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A SCIENCE OF GEONOMICS

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ECONOMICS AND ECONOMIC GEOGRAPHY

The term *political economy* was first used in monarchical France with the meaning of "a set of rules or principles to guide the king and his counselors in the control of the state."[1] Since the science now has little to do with political affairs, the name has gradually been giving place to the modern term *Economics*. There has long been a tendency to call branches of natural science by names ending in *logy* while the social sciences have in many cases taken names ending in *ics*, as, for example, ethics, economics, civics, eugenics.

During the past twenty-five years a great number of new branches of science have been differentiated and have been given specific names. With the rapid expansion of human knowledge, it is inevitable that this process should go on. In biology this tendency to set off special phases of an older and more inclusive science and to give them distinguishing names, has been proceeding rapidly; a new offspring of biological science is born and christened so frequently that we find difficulty in keeping up with the process.

Geographers have needed new terms with which to designate branches of their science as these have been taking shape. In the case of geography, this need has been met by introducing such descriptive words as physical geography, commercial geography, historical geography, industrial geography, political geography, biogeography, zoogeography, and anthropogeography.

Unfortunately for the science, the name "geography" is associated in people's minds with an elementary study taught in the grades. When geography was added to the list of high school studies, one branch was called physical geography, or physiography, and another was called commercial geography. Since neither of these was taught in the elementary school under these names, they gained recognition as more advanced phases of geography. It is only recently that

[1] Fetter, "The Principles of Economics", p. 8.

authors and publishers have ventured to offer the secondary schools a text book in plain "geography" without the prefix "physical" or "commercial." It is equally true that colleges and universities have been slow in appointing professors of geography under that name; this condition, however, is rapidly changing.

Geography, as a university science, is now having a healthy growth and is being subdivided as other sciences have been. For example, there is a phase of geography which interlocks with history. It deals with the influence of geographical conditions upon historical events. It can hardly be called historical geography, so the rather lengthy term "Geographical Influence in History" is employed. Another phase interlocks with economics and it is this phase of which I wish to speak.

In his *Outlines of Economics,* Ely says (p. 4), "Economics is a science, but something more than a science; a science shot through with the infinite variety of human life. . . . It is frequently said that economics treats of man's efforts to make a living . . . so, similarly, economics has been characterized as the philosophy of human industry. . . . As we prefer to define it, however, economics is the science which treats of those social phenomena that are due to the wealth-getting and wealth-using activities of man."

Fetter says in his *Principles of Economics,* (p. 3), "Economics may be defined briefly as the study of men earning a living." He points out (pp. 9-11) that men engaged in making a living gives rise to that which we call industry; that the purpose of industry is to gratify wants; that "wants among animals depend upon the environment;" that "different animals desire or want different things, but always it is the environment that determines the want and not the want that determines the environment."

All of the above ideas also lie at the foundation of economic geography which deals with men engaged in getting a living under different geographical conditions. The essential idea of economics is *man engaged in gaining a living,* and these activities of man constitute industry. The essential idea of scientific geography is the relation of man's activities to the geographical conditions under which he lives. The economic activities of mankind are, then, the subject of study in both economics and in one phase of geography. Economics, however, is not concerned with men getting a living in Canada as distinguished from men getting a living in Mexico. It is concerned with general laws and principles which are believed to be reasonably true in both countries. Ely gives the following caution:[2] "No system

[2]Outlines of Economics, pp. 7, 8.

of economics is applicable unchanged to all times and all places, . . . the conditions of almost every question vary from country to country and from generation to generation. The student must not expect rules of thumb by which he can decide offhand the economic problems of the particular city or country district in which he is for the moment interested. No general treatise on economics can authoritatively decide the practical problems of particular times and places."

THE NEED FOR AN APPROPRIATE TERM

This clearly assumes that different places possess peculiarities of their own which require that these regional differences be taken into account in the application of economic laws. This implies a branch of science which deals with *the economic activities of man as influenced by his geographic environment,* a subject which has of late been taking shape, but has not assumed a name.

With the words *geonomy* and *geonomic* already in use, though seldom heard, and with the word economics well understood, it would seem that the word geonomics might be employed as a name for this branch of science. Strictly interpreted, the word is not a perfect fit, for it means earth laws; or laws pertaining to the earth. However, a strict interpretation would make the word *civic* and *citizen* apply only to dwellers in a city, and *politics* would apply only to cities, *economics* only to households, astronomy only to stars, and even the term geography would not admit of the definition which is now accepted, namely the study of the earth as the home of man. There is nothing in the word "geography" which implies the home of man any more than it implies the home of horses, or of trees, or any home at all. The recognized difference between geology and geography is not evident in the words themselves. The difference arises from usage, not from derivation. So with the words economics, civics, politics, etc.; their meanings are well understood, but those meanings are the outgrowth of usage and depart widely from the original meanings of the Latin or Greek words from which they are derived. If, therefore, the word geonomics is not a perfect fit, it will share this quality with the majority of other names which have come into use and which serve their purpose quite as well as if their root meanings accorded perfectly with accepted meanings.

We have geochemistry and geophysics—why not geo-economics? Mainly because the latter word is awkward, and when analyzed, would fit the need no better than geonomics. Truly, geonomics might apply as well to economic aspects of geology as of geography; but this would matter very little unless the geologists should also decide that they too desire this word, which is not likely to occur.

EXAMPLES OF GEONOMIC LAWS

In industrial geography we are constantly seeking to explain why, for example, certain industries are developed in one region and not in another; why villages grow into cities at certain points and remain mere hamlets at other points; why this place or that is well situated for carrying on domestic or foreign trade, while some other place is not. In explaining why these things are so, we recognize the outworking of some law. Is it a law of geography? Yes, partly; but perhaps even more truly a law of economics applied to a definite locality or type locality. This would be a geo-nomic law. We might, for example, frame a law somewhat as follows:—"A manufacturing industry which uses heavy or bulky raw materials and requires much mechanical power gravitates toward the source of raw material and tends to locate at points where power can be generated cheaply." Paper manufacturing is such an industry; so is lumber-sawing and steel-rolling. Therefore, the great paper mills are located along the margins of our northern forests and at points where water power is available. Rolling mills are near blast furnaces and coal mines. Nearness, of course, is not measured in miles but in cost or hauling.

Again:—"Industries whose products are of small weight and high value may subordinate considerations of distance from raw materials to other considerations such as labor supply or nearness to markets." New England and New Jersey produce few of the raw materials which their factories use, but the North Central States produce a major part of the raw materials which their factories use. The manufactures of New England in proportion to their weight and bulk are valuable, and can, in large measure, disregard the item of freight charges. Not so with the characteristic manufactures of the North Central States. The industries of both sections have been shaped not alone by geographic conditions, and not alone by economic forces, but *by economic forces operating under conditions imposed by the environment;* in short —by geonomic forces.

Another example: Japan is a country of small area, limited food-producing power, considerable coal resources, large labor supply, and aggressive leadership. Nearby is China, a country of vast size, vast resources, cheap labor, and one of the great potential markets of the world. Clearly, Japan's problems of economic development are much like England's, but very unlike America's. Every step in Japan's economic progress must be directed by her own peculiar geographical conditions. Her national problems are not only economic, they are even more truly geonomic. Canada's economic problems are very unlike Japan's, largely because of difference in geographic conditions.

Argentina's are still different, and so are those of Cuba, of Switzerland, of Denmark, and of every other part of the world. As their geographical conditions differ, their economic problems differ.

DISTINCTION BETWEEN ECONOMIC GEOGRAPHY AND GEONOMICS

As I conceive of the science of geonomics, it is not just the same as economic geography. Geography is mainly devoted to description. It is probable that upwards of 90 per cent of the contents of any text book of geography is descriptive matter; descriptive of the topography, climate, resources, industries, transportation facilities, distribution of people, etc. Along with this goes a certain amount of explanation setting forth how the physical and climatic features of a given region affect agriculture, manufacturing, transportation, etc. Economic geography, if we may judge from the content of textbooks and university courses, is also mainly descriptive. It brings together and correlates information of geographical and economic character pertaining to the United States, Great Britain, France, and other parts of the world; also information pertaining to the production and distribution of commodities. Economic geography may go, and theoretically does go, farther and traces many of the conditions which it describes back to their causes, so far as those causes are geographical. It thus adds interpretation to description and becomes more philosophical, and presumably more scientific.

The science of geonomics presupposes some knowledge of the subject matter of economic geography, and builds upon it. Geonomics is the next step forward from the elementary phases of economic geography. The geographer gathers the necessary geographical information about the regions or countries of the world, and sets it down in orderly fashion, and it becomes the raw material with which the student of geonomics works. The same person may both collect the geographical information, and, later, work it over for geonomic uses, but the finished product in the two cases is different. The geographical material is a body of descriptive matter, while the geonomic material is organized primarily as a body of principles or laws operating under the influence of geographic conditions.

As developed in the United States economic geography makes little reference to the principles of economics. Perhaps this is due to the fact that most American geographers have not been trained economists. One American teacher of economic geography, and so far as I am aware the only one, the late Professor E. V. Robinson, insisted that the economic geographer should be primarily an economist. In an article published in 1909 in the Publications of the American Eco-

nomic Association,[3] Professor Robinson, himself a professor of economics, asks, "What then is economic geography?" and answers,—"Our friends the geographers would doubtless answer: 'Economic geography traces the influence exercised by physical environment upon economic activities.' As I conceive it, economic geography does that, and much more: mainly, it seeks to ascertain and explain the geographic division of labor,—that is, the localization of industries, in terms not alone of physical environment, but of all the factors involved, cultural as well as physical." He goes so far as to insist that "Economic geography is not a part of geography, nor yet a mongrel compound of geography and economics, but an integral part of economics. "For the same reasons, it would appear that economic geography cannot be adequately handled except by a trained economist." This view does not prevail in America, doubtless, because in this country economic geography is usually taught by geographers, and not by economists. Professor Robinson's conception of economic geography would be fairly well served by the name geonomics.

AN EXAMPLE OF A GEONOMIC STUDY

The writer's idea of geonomics may be concretely illustrated in the case of the North Central group of states. As the white man found it, this region was (a) a vast plain—partly prairie and partly forest covered; (b) possessed of rich soil; (c) having an invigorating climate and ample rainfall for agriculture; (d) enriched by great resources of coal, iron, copper, petroleum, lead, zinc, and timber; (e) so level that land transport in every direction was easy; and (f) served by two great waterways, the Great Lakes and the Mississippi River system. These were the foundation facts so far as geography is concerned. Into this region thus endowed came a flood of energetic, industrious, progressive settlers, capable of developing the rich country which they were occupying. The two conditions most essential to economic development were brought together—a great opportunity (the geographical element) and a people capable of making good use of it. This favorable combination was further helped by the fact that the railroad era of rapid, effective transportation promptly followed. For a time, the settlers found employment mainly in the extractive industries,—farming, lumbering, and a moderate amount of mining. Wheat was the principal money crop because (1) the soil and climate were highly favorable; (2) the crop was easily handled and stored; (3) it kept well, and (4) it had a world market to which the Great Lakes and the Mississippi River led.

In the northern part of this region, lumbering soon grew into a great industry, for both economic and geographic reasons. The forests

[3] Economic Geography: What it is and What it is not." Vol. X, No. 1, Apr. 1909.

of white pine were in a region of heavy snowfall and many rivers. The rapid development of the country called for an enormous supply of lumber, timber, shingles, ties, posts, poles, and other wood products. The spring floods arising from the melting snows and the rains transformed the rivers into the cheapest known means of transporting logs to the mills, and the Great Lakes-Erie Canal Route and larger rivers furnished an inexpensive means of delivering the lumber to the markets of the prairie states and the East. Here was the interaction of geographic and economic conditions, an outworking of a fundamental principle: (1) A great natural resource—timber; (2) a rapidly expanding market; and (3) cheap transportation between them.

None of the other new agricultural lands of the world has developed so rapidly and so symmetrically as this Middle West, because none of them combined so many favoring geographical and human factors. The Pampa of Argentina lacks timber, road materials, and coal. Australia is remote, lacks rainfall and does not attract immigrants. The great plains of Canada have a short growing season, are in the far interior of the continent and their natural outlets are closed by ice a large part of the year; and Siberia is still worse off. Our Central States possessed a variety and wealth of natural advantages not duplicated elsewhere in the new lands of the world. Such opportunities attracted energetic immigrants and rewarded them for their labor.

Thus there came into harmonious cooperation in the Central States five great factors upon which a vigorous industrial life depeneds: (1) Abundant raw materials, (2) abundant sources of mechanical energy —especially coal, (3) abundant, energetic, intelligent labor, (4) rapidly-accruing capital, and (5) cheap and efficient transportation. And back of all this was a liberal, helpful government and a devotion to popular education.

A treatment of the Middle West along the above lines might be geography if it were mainly descriptive: it might be geonomics if it investigated not only the geographical conditions, but also the operation of the economic laws under which the development of the region progressed.

The science of geonomics, whether to be so named or not, is already with us; its principles are gradually taking shape in connection with economic geography: it is the branch of geography now undergoing the most rapid growth. We have geo-physics, geo-chemistry, geodesy, geogeny, geomorphogeny, and geomorphology. Perhaps the time has arrived for raising the question of a convenient name for the branch of science which represents the overlapping of geography and economics, and so I have headed this paper *Geonomics* with a question mark.

THE GEOGRAPHY OF THE ITHACA N. Y. REGION

By O. D. von ENGELN

The Ithaca Region is located in western, central New York at the southern end of Cayuga Lake, the longest of the Finger Lakes, and centers about the city of Ithaca, which has a population of 18,948 (1925 state census) and is the site of Cornell University.

PHYSIOGRAPHIC DEVELOPMENT OF THE REGION

The Depositional Period.—During much of geologic time the Ithaca Region was the bottom of a shallow interior sea. This sea varied in dimensions during the geologic ages, was at times widely connected with the open ocean, at others had only a constricted outlet and seems to have been converted at least once into a higher-level, saline basin when salt was precipitated in thick layers over its bottom. These layers are the basis of the present-day salt industry.

The sea bottom, however, must on the whole have been progressively sinking while clay, sand, salt, and lime layers were being laid down. These have shallow water characteristics throughout their vertical sections, yet aggregate thousands of feet in thickness, despite the fact that much of their original upper mass has been eroded away.

A Period of Uplift and Denudation.—During the extensive earth movements referred to as the Appalachian Revolution, this region, in common with wide adjacent areas to the east and west, was raised high above sea level. The uplift in the Ithaca locality seems to have been nearly vertical in direction, as the layered sediments were neither much fractured nor folded Some compressive force was, however, exerted for east-west undulations occur in the rocks.

The original uplift was followed by long periods of denudation at the end of which the region had been worn down to a nearly featureless plain. A final uplift occurred, like the rest practically without compression.

Once more made a highland, the region again became the scene of active stream cutting which continued until late maturity of topographic form had developed. The slight dip of the strata to the south sufficed to bring north-facing weathering escarpments into the relief. The most conspicuous of these south of the Niagara and Onondaga cliffs was that due to the resistant top layers of sandstone in the Portage formation. To the east of Cayuga Lake this Portage escarpment is well developed along the north front of Turkey Hill and quite distinctly bisects the region into north and south halves. The part

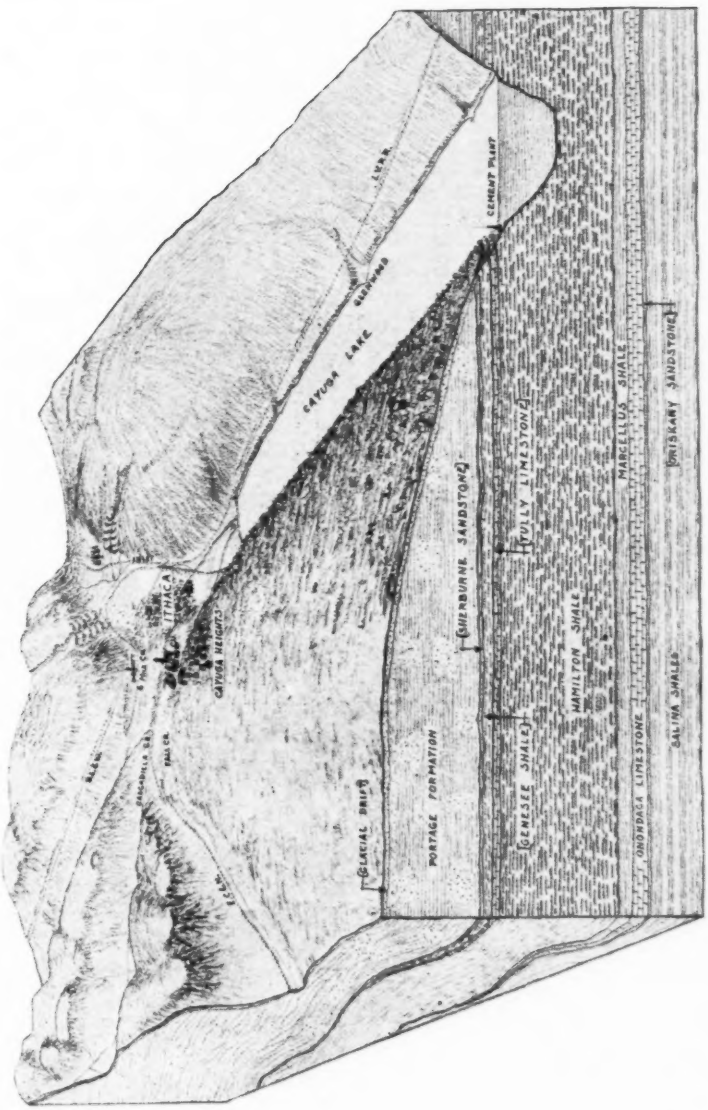


FIG. 1. The Ithaca Region—A Block Diagram.

lying to the north belongs in general to the central lowland of North America, that to the south is part of the Appalachian Plateau. This small region accordingly lies in the boundary zone between two important physiographic provinces. To the west of Cayuga Lake the escarpment fades out as a distinct topographic feature and the merging of the plain and plateau upland is gradual.

At Ithaca a number of streams from the east and south, and flowing in broad, open valleys, were confluent. Coming from the east Fall Creek followed the base of the north-facing Portage escarpment. The stream next south also flowed from the east; its lower course was parallel to Fall Creek. Two other streams, Six Mile Creek from the south and the Cayuga Inlet from the southwest, occupied similar mature valleys. The junction of these streams resulted in the development of an extensive interstream plain by the lateral wearing and weathering away of the spur ends of the divides separating their valleys. A remnant of this plain is now occupied by the campus of Cornell University and the East Hill residential section of Ithaca.

The summits of the divides between these valleys are slightly rolling. To the south, approximately fifteen or sixteen miles from the present head of Cayuga Lake, an east-west divide separated the drainage described from streams flowing into the Susquehanna. The physiographic development, as briefly sketched above, is indicated in the block diagram, Fig. 1.

The Ithaca Region in the Glacial Period.—The Glacial Period followed the denudation of the region to maturity. The advance of the ice was from the north so that it thrust its front against the Appalachian Plateau border. However, numerous breaches in the plateau edge made by north-flowing streams afforded channels by which the ice could project into the highland area in advance of the main front. Hence, these north-south valleys were first occupied by the glacier and, as the ice thickened, they became also the main channels of ice movement southward; were, in other words, the routes of the thickest, most powerful and most rapidly moving ice currents. The erosive effect of the ice was thereby concentrated in the north-south valleys and these valleys were much overdeepened by glacial excavation. Thus the basins of the Finger Lakes, with bottoms approaching and below sea level were developed. At the heads of the north-south valleys, the east-west Susquehanna divide was overtopped and the ice passing over proceeded to cut away this comparatively narrow barrier. Thus through valleys, low, channeled gaps, interlocking the northern drainage with the southern drainage were developed. The Cayuga Inlet and Six Mile Creek valleys in the Ithaca region are notable examples of this phenomenon.

The lower end of the Cayuga Inlet valley (in part possibly because it was originally larger, in part also because it was more directly in line with the ice movement) was eroded more deeply by the ice than the valleys to the east. Hence while the Cayuga Inlet valley now enters the main Cayuga Valley accordantly the floor and lip of Six Mile Creek valley have been left hanging. The same relations are much more conspicuously presented by east-west valleys, those of Cascadilla and Fall Creek. These troughs were nearly at right angles to the line of ice movement, hence were occupied only by diverted and relatively feeble glacial currents. Consequently when streams once more flowed in these east-west valleys they plunged, at their lower ends, in a series of cascades to the levels of the much deeper north-south Cayuga Valley. As time went on the difference in resistance of the layers of the horizontal bed-rock structure became effective in developing step falls. As these falls wore back upstream progressively, gorges were cut that now mark the north and south boundaries of the Cornell University campus. This campus occupies the western border (of the portion that the ice erosion failed to cut away) of the previously noted interstream plain. Near by are many other east-west streams that show the same hanging condition with reference to the Cayuga Valley and a similar later development of gorges and falls.

A further complication in the development of the valleys must be considered. There were probably in this region, two, if not more, ice invasions. After the withdrawal of the first ice, glacial debris, unevenly deposited in the valley bottoms, commonly diverted the streams from the axes of the troughs to one side or the other of the valleys. After cutting through the thinner veneer of morainic stuff at such points the streams were let down on bed rock; into which they proceeded to cut gorges. During the interval between glaciations these gorges developed to much larger size than has been possible in post-glacial time. A second ice advance resulted in further morainic deposits not disposed as the first had been. Consequently the previously developed gorges were in part filled up and the streams once more started along new channels over the valley bottoms. In places they found the earlier gorges and at such sites rapidly washed out the unconsolidated glacial material, elsewhere they entered on gorge cutting anew. Thus the middle and lower sections, especially, of the east-west streams are at present marked by amphitheatre hollows where a stream is flowing along the line of the older wide gorge and these hollows are connected by short sections of young, post-glacial gorges.

Though much lowered, the east-west divides between the Susquehanna and north-flowing drainage, were not wholly destroyed in the formation of the through valleys. Furthermore a relatively pro-

longed halt in the withdrawal of the ice resulted in the development of pronounced, moraine-loop barriers across these valleys; in many instances at the sites of the former divide sections. Thus morainic ridges, plus so much of the original rock divides as remains, formed water-partings of considerable elevation during the later retreat of the ice and have continued to function thus. In the period immediately following the building of the moraines, water flowing north from these divides was ponded back by the ice that still occupied the lower ends of the valleys. In this fashion a number of pro-glacial lakes were created. As the ice melted back farther to the north, successively lower channels of escape for the water were exposed and the lakes fell to lower and lower levels.

During the existence of the high level lakes a large amount of morainic material was available for stream transportation and furnished sediment for deposit on the lake bottoms. At the stream mouths huge deltas of gravel and sand were formed at each successive level of the lakes. These deltas are now conspicuous topographic landmarks as they project in well developed, steep-front and flat-topped terraces on the valley sides. Enough time has elapsed since the complete disappearance of the ice barrier, and the establishment of the present drainage levels, for the extension of the delta building (at the mouths of the various streams confluent at the head of Cayuga Lake) to become joined and completely to fill in the end of the basin. Over this delta, later flood-plain and alluvial deposits have been spread, and the mile and a half long, level-topped Inlet Plain has been formed. On this plain the main part of the City of Ithaca has been built.

Such, in brief, is the origin of the site.[1]

CLIMATE

Temperature Conditions.—The average and extremes of temperature in the Ithaca region vary several degrees according to the exact locality, the chief factors of this difference being relative elevation and distance from Cayuga Lake. The average annual temperature at Ithaca (campus of the University) is 47° F., that for the six summer months being a trifle below 60° F. and for the winter months 33° F. In the upland valleys to the south and west the annual average temperature is 2° F. lower than at Ithaca though the difference in altitude between the observing stations is only a little over 100 feet. This relation holds essentially for all the months of the year, as it does also for the average difference in temperature between the two stations on the hottest days for a num-

[1] A more complete and detailed account of the Physiography of the area will be found in the Watkins Glen-Catatonk Folio, No. 169 of the U. S. Geol. Surv.; "Topography" and "Physiographic Record" sections.

ber of years. But the upland-valley-station record shows an average of 6° F. greater cold for the coldest days in a number of years. From this it would appear that the effect on average temperatures of greater elevation and remoteness from the lake is a slight annual lowering of the temperature accentuated in winter extremes. The highest summer temperature officially recorded at Ithaca is 102° F., the lowest —20° F. This shows the climate to be one of great extremes in annual temperature and the range from day to day is also great; thus it extended over 30° F. in 18 hours following midnight January 30, 1915.[2] The average temperature for the months when the University is in session, October to May, inclusive, is only slightly below 40° F., the optimum average temperature for mental activity as defined by Huntington.[3] Perhaps the students and faculty have not appreciated this favoring geographic influence, but no doubt it has been exerting its due effect.

Lake Influences.—The influence of Lake Cayuga is particularly marked in connection with the length of the growing season as delimited by the last and first killing frosts. At Ithaca the average date of the last killing frost in spring is May 4, and the first one in fall October 10, giving a growing season of 159 days. In the upland-valley station, previously referred to, the corresponding dates are May 18 and September 27, hence a growing season of only 132 days. This is almost a month's difference and there is reason to think that in locations otherwise favorable and nearer to the lake than the Weather Bureau station at Ithaca the season is even longer. It may be noted, in comparison, that the growing season around New York city is 200 days, at Buffalo, N. Y., 174 days, at Columbus, Ohio, 183 days. In central New York state latitudes, hillsides with southern exposure are warmest; next come those facing east, then west, and last those looking to the north. As Cayuga Lake extends north and south, a slope sheltered from the prevailing wind situated on the west side of the lake would appear to have a distinct advantage in growing season.

The Ithaca region lies within the belt of the tracks followed by the numerous cyclonic storms that pass over north-eastern United States. The resulting cloudiness reduces the amount of sunshine received at Ithaca to 8% less annually than that received at New York City, and, in April, to 12% less. As April is the critical month

[2] These and other climatic data that follow are for the most part from: Climatic Summary for Ithaca, N. Y. Published Sept. 1914, Local Office U. S. Weather Bureau, Ithaca, N. Y. and: Frosts in New York, W. M. Wilson, Bulletin 316, Cornell University Agr. Exp't Station, N. Y. 1912.

[3] Climate and Civilization, Huntington, E., New Haven, 1915, 1924.

when the soil is being warmed up and growth started it would seem that the slopes which face the morning sun have the advantage in this also.

The Annual Precipitation.—At Ithaca itself the average annual precipitation is 34 inches, at the upland-valley station near by it is 38 inches; New York City has 45 inches. As most of the soils of the Ithaca region have poor drainage conditions; are apt to be too wet in spring and to dry out in summer it is indicated that a higher summer rainfall would be of material benefit to the agriculture of the area. The annual snowfall averages 56 inches as compared to 35 inches at New York and 47 inches at Binghamton. This snowfall generally persists for considerable periods and affords good sledding, thus, before the advent of motor trucks, materially facilitated country hauling in winter. The prevailing wind direction is from the northwest, 30% of the time, followed by winds from the southeast for 23% of the time.

Several minor climatic influences may be noted here. Though possessed of romantic scenery, a lake, gorges, waterfalls, and hills, and though readily accessible from several large centers of population the region has never had as great a vogue as a summer resort as might be expected, the primary reason being the cloudiness and coolness of the early summer months. This has made lakeside resorts precarious business enterprises. Then, too, bathing is not good, partly because of the general absence of good beaches and the abrupt deepening of the water offshore, also because when a warm south wind blows, the surface water is blown to the north end of the lake and the water is cold near Ithaca; while on days when the waters are warm, a north wind usually makes the air too cool for comfort. The open reaches of the lake are admirable for sailing, but sudden squalls are common because of air drainage coming down the hanging valleys. Because of this phenomenon and because of the all-year-round low temperature of the lake which reaches a depth of 435 feet, a number of accidents and near-drownings from upset sailboats and an even greater number of cases of actual loss of life from overturned canoes have occurred. This record also adversely affects the popularity of the lakeside as a summer resort.

However, with the increasing popularity of motor touring, involving stops usually only overnight or for part of a day, the scenic attractiveness of the region as a whole, coupled with the ample provision of hard-surface roads, is yearly attracting greater numbers of summer visitors. Accordingly those who make it their business to serve this passing traffic are prospering abundantly.

SETTLEMENT

Native Vegetation of the Region.—As early as 1656 white men, two

Jesuit Fathers, entered the Ithaca region and dwelt among the Indians for some nine months. But the mission was not re-established until 1668. Thereafter it continued until 1684. In 1671-72 Father Raffeix was temporarily stationed at this mission and wrote an account of the natural aspect of his "canton." From this it appears that although most of the country was forested, the Indians had made considerable clearings, the larger ones being "oak openings" which were burnt over annually for hunting purposes, while smaller tracts near the villages were planted to corn. Apparently these rather extensive cleared areas were located almost entirely to the north of the line of the Portage escarpment. Over the dissected plateau area, extending from Ithaca south to the Susquehanna, the forest was practically unbroken, dense, and tangled; it constituted the "dark-forest" as characterized by Raffeix and other early observers. On the rolling, upland summits white pine predominated. In the valley bottoms at Ithaca, particularly near the head of the delta-flood plain, the white pine merged into oak, elm, and maple woods. But there were also extensive cleared fields, cultivated by the Indians on this ground, together with apple orchards; this fruit apparently was introduced by the Jesuits. The same type of forest continued northward along the shores of the lake and on the lower lands to the east of its basin. The front of the delta was marsh land, Lake Cayuga was called "Tiohero" or the "lake of flags and rushes" by the Indians because of such growth at both its northern and southern ends. Extensive swamps were also present at all the water partings. In these divide swamps the tamarack, black spruce and balsam fir were native and still occur, as well as the hemlock; though the last is much more abundant on the sides of the post-glacial gorges. The tamarack, spruce and balsam fir, as well as the Canadian primrose (*Primula mistassinica*), which is found on the cold, wet, south walls of the gorges, are to be regarded as subarctic species which migrated from the north before the continental glacier and were left behind in such isolated but congenial habitats on the retreat of the ice. *Primula mistassinica,* for example, now has its natural habitat about the shores of a lake of the same name on the Labrador peninsula. On the dry and sandy knolls of the dissected, high-level deltas other exceptional forms occur, as for instance, the pitch pine and the red, or Norway pine. In these special instances the native flora shows interesting adaptations to its geographic environment.

How Man Has Modified the Region.—Thus practically all the southern part of the region (the Indian clearings were largely to the north) had originally a dense forest cover. Of this comparatively little remains. Clumps of trees, farm woodlots, still dot the lower slopes and valley bottoms, and a ribbon of forest marks the course of each of

the gorges. Larger tracts of woodland occupy the higher parts of the uplands and the glacially over-steepened slopes of the through valleys to the south; and are also found on the swampy divide areas and over rough and stony morainic ground. Practically all of this is, however, second growth timber. As early as 1853 it was noted in a local pamphlet[4] that three-fourths of the county (Tompkins) was improved land. In 1886 the only virgin tract of white pine consisted of an area about forty acres in extent that occupied the hillocky moraine at the head of the Inland Creek, and this has since been completely cleared. Much of this timber was undoubtedly converted into lumber. In 1832 the export of lumber from the county had an annual value of $400,000, but in the same year ashes brought $27,000, indicating that much timber (estimated at 60%) was burnt in clearing land for agriculture.[5] The ashes were used to make potash, an industry that began as early as 1804.[6] Latterly even the small timber on the steepened slopes and uplands is being cut and the land allowed to stand idle or used for pasture. Formerly the thick woods on the uplands held back the melting of the winter snows, now the water goes off very rapidly after spring first sets in. Much of the land now cleared ought to be replanted to forest. Neither the early nor later clearing had much reference to geographic conditions. Woodlots still occupy rich lowlands; barren hillsides too steep even for good pastures were cleared. About thirty years are required to regrow merchantable timber on land that has been cleared, and as this is a long time investment it would be well to exempt such lands from taxation until the forest is cut. Land that would not sell for over $15.00 per acre as farm land produced nearly $5.00 per acre annually, in natural regrowth of timber without care, for the 22 years required to produce the forest.[7]

The primitive forest abounded in game. Deer were very plentiful, as were also bear; these animals supplied the early settlers with most of their meat.

The Sites of Indian Villages.—In September, 1779, detachments from General Sullivan's army sent out by Washington to "Chastise and humble the Six Nations," utterly destroyed the Indian villages along Cayuga Lake and wasted the native plantations and orchards. One of these villages, Coreorgonel, consisting of 25 "elegantly built houses" was situated on the morainic hillocks that terminate the delta-flood plain area on the west side of the Inlet Creek. The Indians who occupied it

[4] "Ithaca as it was," H. C. Goodwin, Ithaca, N. Y., 1853, p. 3.

[5] "Facts Relative to the Trade, etc., of the County of Tompkins," Ithaca, N. Y., 1832, p. 7.

[6] "Early History of Ithaca" H. King, Ithaca, N. Y., 1847, p. 13.

[7] An Agricultural Survey of (part) Tompkins Co., N. Y. Warren, G. F. and Livermore, K. C., et al. Bull, 295 Cornell Univ. Exp't Station, Ithaca, N. Y. 1911 p. 471.

were not of Iroquois stock, but Tutelos, originally inhabitants of the piedmont country of Virginia and the Carolinas. This is of interest in connection with the place names of the region, for the Tutelos removed to this point in 1753 (after concluding a peace with the Iroquois who had long harried them) in company with an allied tribe, the Saponis, who had suffered like tribulations. The Saponis settled in one of the through valleys on the upland to the southwest of Ithaca and this today is called "Pony Hollow," a corruption of the original Saponi Hollow.[8] Although their settlements were destroyed and the Indians themselves driven toward Niagara in 1779, and although they had formally ceded their lands to the state in 1789, it seems that a considerable number of the natives remained in the Cayuga country for some years later, as they are mentioned in the accounts of the first white settlement of the region, 1788-1790. Thus it is related that in winter the natives pitched their wigwams on the level lands within the mouth of the Six Mile Creek gorge near State Street, in Ithaca, securing rather complete protection from cold northwest storms under the steep and high rock walls. With the advent of spring the Indians moved to higher ground particularly to the site of the earlier town of Coreorgonel, where there were native orchards. Thus it appears that geographic conditions exerted some influence on the habits of the Indian residents of the region.

In 1789 the first trading was done by the Ithaca community and consisted of the exchange of maple sugar, and marten, otter, beaver, fox, bear, and deer skins, for tea, coffee, crockery, hardware, lead, gunpowder, and liquor.

The First White Settlers.—In September, 1789, three white families, comprising nineteen persons, removed from Kingston, N. Y., to the present site of Ithaca, bringing with them some household chattels. A month was consumed by this party in its journey from Kingston to Owego. The route of the first settlers in the main followed geographic lines and is now paralleled for the most part by railways. From Kingston they went northwestward on a route that is now followed by the Ulster and Delaware railway. Crossing the divide of the Catskills they arrived at the headwaters of the East Branch of the Delaware river, probably near the present village of Arkville. Here canoes were fashioned in which the party floated down the Delaware river to a point a little below the junction of the East and West branches of that stream. This portion of the route is now followed by the Delaware and Northern railway and the New York, Ontario and Western road. From the Delaware they portaged across the

[8] See Handbook of American Indians, Bulletin 30. Parts I and II, Bureau of American Ethnology, Smithsonian Institution 1907, 1910, for references to literature.

divide between that stream and the Susquehanna at what was called its Great Bend near Lanesboro, Pa. No railroad crosses the divide just at this point but the Erie railroad makes the climb from the Delaware to the Susquehanna valley just a few miles farther north and continues westward in the valley of the Susquehanna river to Owego and beyond. At the Susquehanna the settlers once more constructed canoes and floated down stream to Owego. While modern traffic between the east

FIG. 2. Early Roads and Routes across New York.

and the west has abandoned the settlers' route in large part, it is nevertheless of geographic interest to note its directness and the extent to which the stream courses were utilized in making the trip. (See Fig. 2.)

Nineteen days more were needed to complete the last stage of the journey, the part from Owego to Ithaca, a distance of only 29 miles. While an Indian trail, succinctly described as a well-beaten path, marked the way between these points, it seems that the settlers secured horses and stock at Owego, presumably wagons also, consequently it was necessary for them to clear off the forest in advance of their march, hence the long time it took to cover the short distance. The highway they opened in this manner followed one of the lowlying gaps across the upland country resulting from glaciation, the through valley of Six Mile Creek; destined to become, later, an important factor in the development of the region.

Cause of White Migration.—Economic motives, a desire to improve their fortunes, led the settlers to emigrate. Purely geographic considerations, however, must have determined their choice of a new home. This is a nice distinction but one that may very fitly be made. It is also safe to assert that they would not have pushed on for 29 miles from Owego so arduously without good reason. While the through valley of Six Mile Creek has since developed an ample acreage of cultivable lands, it must be remembered that primitively this section was densely forested while to the north the Indians had cleared large areas. But it was probably the wide expanse of almost perfectly level land on the delta-flood plain at the head of Cayuga Lake, with its area of fertile, deep, and well drained soil on its eastern side, in view of the rich and immediate agricultural returns these acres promised, that exercised the controlling influence in the choice of a site for settlement. Visions of a future populous town because of the location at the head of the lake and the abundant water powers adjacent may also have had a bearing on the decision.

The Localization of the First Settlements.—The immediate location of the first dwelling places was guided by geographic conditions. Three large streams, Fall Creek, Cascadilla, and Six Mile Creeks emerge from the deep rock gorges that terminate their hanging upper valleys onto the lake-head plain on its east side; no stream of any size on the west side. Because of the abrupt change of grade at the ends of their gorges these three streams have built coalescing alluvial fans on the surface of the delta-flood plain, making the land higher and dryer on its eastern side and pushing the Inlet stream over to the base of the western valley slope. Accordingly, as an early writer remarks, the exact location of the first cabin was determined "by the transporting power of Cascadilla Creek." At this point an Indian clearing existed and here, too, the first crops were planted. This first dwelling, moreover, was just to the north of the mouth of the gorge of Cascadilla in which there were considerable waterfalls only a short distance

upstream. The immediate utility of such waterpowers to the settlers is suggested by the fact that as early as the second year a flour mill, crude, to be sure, but capable of grinding 25 bushels of grain per day, was erected at the mouth of the Cascadilla gorge. In Six Mile the waterpowers were farther upstream, less accessible; the immediate mouth of Fall Creek seems to have been very swampy, but these streams, too, were put to work at an early date. It is interesting to note further that the business center of Ithaca has grown up on the tract of land between the gorge mouths of Six Mile and Cascadilla Creeks, the area that was first occupied.

Origin of the Name Ithaca.—The young settlement early acquired the name of "Maricles Flats" or "The Flats" because of its environment. Its present name Ithaca was probably given it in about 1808 by Simeon DeWitt who, in 1780, was appointed chief Geographer of the Army of the Revolution, and, in 1784, Surveyor General of New York State. While "The Flats" was not a very euphonious appellation, it did express a geographic relation, hence it seems unfortunate that a geographer, at least by one-time title, who later resided in the settlement, should not have hit upon some more fitting term. This name has, however, since the founding of the university, a degree of appropriateness he could not have foreseen. DeWitt himself seems not to have been responsible for the many other, and earlier, classical place names found in this part of the state, but it appears that the naming of Ithaca served as a precedent where similar changes were made in later years.

TRANSPORTATION ROUTES[9]

Contacts With Outside Regions.—The Jesuit missionaries, who were probably the first white men in the region, undoubtedly came by way of the St. Lawrence and Great Lakes route from the east, entered the northern end of Lake Cayuga and followed it southward in their explorations. The first merchant of the region, an itinerant trader, brought a small boat load of goods (tea, coffee, earthenware, drygoods, hardware, gunpowder, lead, and liquor) up Cayuga Lake and exchanged these articles at Ithaca for maple sugar and furs. The first settlers came by way of the north-and-south through valley of Six Mile Creek from Owego on the Susquehanna River to the site of Ithaca at the head of Cayuga Lake. These facts suggest the early importance of the north-south lines of travel and communication in the region. It should be mentioned, however, that a considerable number of the early pioneers who settled at Ithaca came from the east along the course of Fall Creek and that it was along this route

[9] Location of Towns and Cities of Central New York. Tarr, R. S., *Bull. Amer. Geog. Soc.* Vol. XLII, 1910, pp. 738-764.

that the first road through the forest was cut, completed in 1795, connecting Oxford on the Chenango River with Ithaca.

In the first third of the nineteenth century water routes were considered all important. At an early date nearly every stream was utilized as a highway and with the opening of the Erie Canal in 1825 a further impetus was given to water transportation. Railroads were then considered useful primarily as a means to effect portage between water routes. From central New York the Susquehanna River was the great highway to the east until after the opening of the Erie Canal. When the Erie Canal was completed, and opened the way to the west, it was felt that a north-south route connecting the canal highway to the west with the Susquehanna River route to the east would be of great importance. Ithaca, because of its geographic position at the lake-head terminal of western navigation, on the shortest overland route to the Susquehanna, seemed destined to become a great commercial center.

COMMERCIAL IMPORTANCE OF ITHACA 1810-30

As early as 1810 Governor Clinton wrote,[10] "The situation of this place (Ithaca) at the head of Cayuga Lake, and a short distance from the descending waters to the Atlantic, and about 120 miles to the descending waters to the Mississippi, must render it a place of great importance."

For this prediction and similar fond anticipations later there was in those times ample justification, chiefly because the Ithaca region was then the originating point of a considerable bulk of export traffic that utilized the routes in question. Between 1808 and 1811 a turnpike, or toll road, was built over the Six Mile valley route. During the war of 1812 the supply of gypsum from Nova Scotia was cut off from the States, and this fertilizer was secured in large quantities along the east shore of Cayuga Lake to the north of Ithaca. On a single day (between 1812 and 1815) it is recorded that as many as 800 teams passed over the Ithaca and Owego turnpike engaged in hauling the "plaister" (land plaster) to the Susquehanna River, on which it was floated to the south and east. This commodity continued to be of importance in 1825 and the traffic in it is urged in 1862 as a reason for building a ship canal from the foot of Lake Cayuga to Lake Ontario. Salt was another mineral product shipped in quantity from Ithaca at an early date, 8,000 barrels in 1825 and 2,250 tons in 1832.[11] In the latter year nearly 2,000 tons of lumber and 8,700 tons of wheat and flour were sent out of the region. At that

[10] Life and Writings of DeWitt Clinton, W. W. Campbell, N. Y. 1849.

[11] Facts relative to the Trade (etc.) of the County of Tompkins, N. Y. Pamphlet printed by Mack and Andrews, Ithaca, 1832, p. 7.

time most of this merchandise was being sent north and east through Cayuga Lake and the Erie Canal, and it was estimated that this freight paid canal tolls to the amount of $150,000.00 annually. At an earlier date (1810) Governor Clinton describes the shipment of flour from Ithaca to Baltimore, Montreal, and New York. For Baltimore it was conveyed overland to Owego, where "arks" (barges) could be had for $75.00. On these the flour was floated down the Susquehanna River, arriving at its destination in from 8 to 12 days. At Baltimore the arks were sold for half price as "the rapids of the Susquehanna are fatal to ascending navigation." To Montreal the route was over that lake and the St. Lawrence River to the Canadian port. Montreal was considered the more certain market, expense of transportation being about the same to either Baltimore or Montreal. Goods were also shipped to and from New York City by way of Cayuga Lake, Seneca and Oneida rivers, Oneida Lake and Wood Creek, by canal (completed 1797) across the divide between Wood Creek and the Mohawk River at Rome, down the Mohawk (canal around Little Falls completed 1794) to Schenectady and from thence overland to the Hudson at Albany. It required six weeks to make the round trip from Ithaca to Schenectady with a boat carrying from 100 to 150 barrels of flour. The boats used were small and were propelled for the greater part of the way by poles.

In view of the slowness of such transportation it is not surprising that the advent of the steamboat effectively stimulated lake traffic and seemed to emphasize further the coming importance of Ithaca as a terminal point on the shortest route from the east to the west. Passenger business particularly was affected. Thus in the Ithaca Journal of June 7, 1820, it was stated that passengers from New York City for Buffalo could leave the former city at 5 p. m., go by boat to Newburgh, there take stage and arrive at Ithaca on the evening of the second day. Embarking on the Cayuga steamer that evening they would be landed at the foot of the lake next morning and resuming the stage arrive at Buffalo that night, making the whole journey in 3 days, one day less than by way of Albany. By 1837 there were three steamboats and from 70 to 100 canal boats in service on Cayuga Lake. The latter were in large part engaged in conveying coal from Ithaca to the Erie Canal and this coal traffic was a very important factor in the apparent destiny of Ithaca as a great commercial center.

Topographic Conditions in Relation to Transportation Routes.—In about 1825 the importance of the coal deposits, (principally anthracite) in the Pennsylvania district directly to the south of Ithaca began to be recognized. Iron ores also had been discovered and the huge traffic that promised to develop in these commodities gave a

further incentive to the project of connecting the Erie Canal with the Susquehanna highway by some more adequate means of transportation than by wagon. It was proposed that the state should aid in the building of a canal over the divide between the lake head and river navigation and the Ithacans urged that this canal should follow one or the other of the two valleys leading south from their town as these were the shorter routes.[12] There were, however, competitors who insisted that the route should be from the head of Seneca Lake and it was in this valley that the north-south canal was dug, the Chemung Canal, connecting the head of Seneca Lake with the Chemung River at Elmira, completed 1833.

There were good geographic reasons for selecting the Seneca-Chemung route as will appear later. Meanwhile the Ithacans and Owegans, undeterred by their failure to secure the canal and retaining faith in the geographic advantage of their shorter route, organized a company and with private capital built a horsepower railroad through the Six Mile Valley. While the Six Mile Valley route is at least 10 miles shorter than the Seneca-Chemung route to the Susquehanna, the geographic handicap of the Six Mile route that more than offset the advantage of less distance became plainly manifest when the railroad was built. As the mouth of the valley is hanging above the Ithaca level (due to differential glacial erosion as detailed in an earlier paragraph) it was necessary to convey the cars down the steep slope from the hanging-valley lip on an incline. The trains were hoisted and lowered by a system of pulleys and ropes, operated at first by horsepower and later by a stationary steam engine, through a vertical distance of 405 feet within a horizontal distance of only 1733 feet. The grade of this incline can still be seen on the nose of South Hill. It is interesting to note that the same cumbersome device was also employed on the Mohawk and Hudson Railroad, the earliest portion (1831) of the present New York Central System, to raise trains from Albany into the Mohawk Valley. But while the grade at Albany was readily overcome later, the modern railroad line (Owego Branch, Delaware, Lackawanna and Western) that has succeeded the original Six Mile Valley enterprise is at present able to descend to the Ithaca level only by a series of switchback spurs. See Fig. 1. Another road, (E. C. & N. R. R.), built later in the same valley, does not even attempt to make the descent, but discharges Ithaca freight and passengers at East Ithaca, a station on the level of the hanging valley lip.

The glacial through-valley south of Seneca Lake is not hanging,

[12] "Considerations of the Claims of the Southern Tier of Counties." "Addressed to the Representatives of an Intelligent Public." Pamphlet Albany, N. Y., 1825.

furthermore, its bottom is aggraded with morainic and out-wash material throughout its length. Hence the cutting of the Chemung Canal through it was a comparatively easy task. The Chemung canal had, too, the advantage of an adequate feeder in the Chemung River whose flow was in part diverted for the lockage down to the level of Seneca Lake. Then the divide at Horseheads is only 900 feet and the level of Seneca Lake 444 feet, while the divide in the Six Mile Valley has an altitude of 980 feet and the Cayuga Lake level is 384 feet. The Seneca-Chemung route has, therefore, a lower divide and the rise from the lake level is much less. A canal in the Six Mile Valley would have been a practical, if not a physical, impossibility. The horsepower railroad with the system of inclined planes was not an absolute failure but it was not a real success and within a few years the company went into bankruptcy.

When the citizens of Ithaca, Owego, and Athens in 1825 petitioned the legislatures of New York and Pennsylvania for state support for a canal to connect Ithaca with the Susquehanna, they proposed either the Six Mile route or a route through the Cayuga Inlet Valley as preferable to the Seneca route. The Cayuga Inlet Valley like the valley south of Seneca Lake is not hanging and its bottom is also aggraded throughout with glacial deposits. But the divide is at 1040 feet, the distance from Ithaca to the Susquehanna at Athens greater than from Watkins to Elmira by 13 miles, and there is no large feeder available at the high level. Hence the Seneca-Chemung route was chosen for the canal but the Cayuga Inlet Valley was made, later, the route of the Lehigh Railroad, the only through line entering Ithaca. The passenger business of this road between New York City and Buffalo is now sent through Ithaca but the freight business is largely routed over the other loop of the road that parallels Seneca Lake. The reason for this discrimination is that leaving Ithaca in either direction involves a climb of 450 feet or more, while between similar points on the Seneca Valley route the grades are only a little over 100 feet. The railroad does not, however, descend to the level of Seneca Lake at its head, but like the E. C. & N. Railroad in the Six Mile Valley, discharges freight and passengers for Watkins on a hillside station above the lake. The climb out of Ithaca to the north might have been almost entirely eliminated by following along the west shore of Cayuga Lake. But the road across the interlake country had been built before its incorporation into the Lehigh system, it already served a fertile farming country, it connected the towns built at the heads of the gorges[18] and the advantages of the level route would have been more or less offset by the necessity of winding around the minor inden-

[18] Tarr, Loc. cit.

tations of the shore. The branch Lehigh road built along the east shore of the lake suffers from the latter defect.

Another transportation project by which the Ithacans hoped to make their city a terminal point was a direct ship canal to Lake Ontario, in order to get in touch with the western commerce and the Montreal market. Here they came into rivalry with the Oswegans whose route was shorter and better supplied with water. The Ithaca project, however, seemed likely of realization in 1829-1835 and led to a fever of real estate speculation in the community which abruptly collapsed in the national panic of 1837. When first agitated, this canal was to be used in conjunction with the horsepower Six Mile Valley railroad. In 1862 the project was revived with the idea that the waterpowers from the hanging valleys could be used to grind western wheat and that Lake Superior copper ores could be smelted at Ithaca with anthracite brought over the Six Mile Valley railroad from the Pennsylvania fields to the south. But coke from bituminous coal shortly supplanted the use of the costly anthracite for smelting and the wheat country moved still farther westward.

Ithaca a Terminal of the Erie (N. Y. S.) Barge Canal.—The Inlet Harbor of Ithaca has been improved and made one of the southern terminals of the new Erie Barge Canal. It may be that this will give some impetus to water commerce on Cayuga Lake centering at Ithaca but it can not well do much. In the early days when the Ithacans first anticipated great growth, their expectations were built primarily on the basis of the export tonnage of lumber, plaster, flour, wheat and salt originating in the territory. They also hoped to become the outlet for the Susquehanna country. The lumber is gone, the plaster no longer in demand, as a great wheat raising section the region cannot begin to compete successfully with the western lands, and salt is about the only one of the early bulk products still produced in quantity. The railroads have absorbed the Pennsylvania coal traffic and carry it over other routes. The Hudson-Mohawk gateway enabled New York City to surpass Baltimore and Philadelphia as seaports, hence the difficult grades of the more direct cross-plateau routes make them of importance only in the coal carrying trade, and this does not affect Ithaca except in the matter of local consumption. If Ithaca ever becomes a commercial and shipping center of importance it must be on the basis of development of resources within the immediate region. As these seem totally inadequate to bring about such a result, Ithaca can not hope to become, as it did once, "the great central city of New York State."

AGRICULTURE

A number of geographic factors affect the agricultural conditions in the region, especially with reference to the kind of crops that have

and can now be produced profitably. The origin of the soils, the topography of the region and its climate must all be taken into account.

The Soils of the Region.—The soils are for the most part of glacial origin, rock material ground fine by the glaciers, but much of it has been reassorted and redeposited by water action. The uplands above the level of one thousand feet are covered with glacial till. As the bed rock is mostly shale and sandstone, the former predominating, the till material consists of commingled shale fragments of small size with clayey and sandy fine particles making up the bulk of the mass. The substratum is often very dense and hard, the soil itself is usually thin, deficient in lime content, and poorly drained. The shallowness is due to the comparatively light load of material transported by the ice in the thinner masses that moved over the uplands and their rapid melting off, the low lime content to the shaly bed rock from which it was derived and the poor drainage to the compaction of the material by the weight of the ice and to the fact that its clayey nature lends itself to puddling. These soils are the Volusia series whose worn out condition has been held in part responsible for the decline of farming in central New York. The upland country to the south of Ithaca has in fact been described as an abandoned farm district.

Decrease in Rural Population.—The characterization as an abandoned farm district rests on the evidence of decrease in rural population and the number of unoccupied houses. For these facts the nature and condition of the soils are not wholly responsible. There are no abandoned farms in the sense of abandonment of title. The decrease in population and the resultant vacant houses are primarily the result of the introduction of machinery in farm operations, and it has been shown by a detailed survey[14] that the larger farms that have come from this change in methods are uniformly more profitable than small units. The region was settled in the days of the scythe and grain cradle. Hill slopes too steep for modern cultivation were then cleared and farmed. These now are waste land or used only for pasture. As noted in an earlier paragraph they should be returned to forest before the soil is all washed down.

Adjustment in Various Phases of Agriculture.—In the days of early settlement, much of this land as well as that at lower levels was planted to wheat, as is evident from the export figures quoted. Now only 5% of the total acreage in the townships surveyed in detail is devoted to this crop. Probably the depletion of the organic matter originally present in the soil due to continuous cropping is in part responsible for the decrease. Another reason for the decline of the wheat crop was the appearance of insect enemies. But what wheat is now raised gives

[14] Warren & Livermore, *loc. cit*

a better yield per acre than the average for the wheat-growing states to the west. Hay is, however, now the universal crop, covers 56% of the acreage, buckwheat 8% and potatoes 3%. Topography and climatic conditions are also in part responsible for the decline in farming on the uplands. With the advent of railroads, shipping points were almost all concentrated in the north and south through-valleys whose levels are from 500 to 1,500 feet below the hill farms. The glacial overdeepening of these valley troughs made very steep slopes; hence all the descent is accomplished in a very short distance. Roads, moreover, were laid out at an early date without reference to the valley stations, therefore often lead straight up hill for from 400 to 800 feet, just beyond the railroad. Because of such grades, bulk crops, potatoes, for example, to which the soil is adapted, cannot be very profitably produced. This topographic difficulty must also be contended with in hauling market milk. Motor transportation, recently, has in some degree offset this geographic handicap. Climatic limitations are imposed by the shortness of the growing season and the coolness of summer which makes the production of corn for grain uncertain. The normal climatic sequence for the region of a wet spring followed by a dry summer is a particularly unhappy combination for the thin clayey upland soils. They are boggy and cold in spring planting time, ploughing tends to puddle them and then, in the summer droughts, they dry out and bake, partly because they are thin and partly because the puddled condition prevents the vertical rise of water.

In addition to the handicap of the hills in hauling milk to market there is a further disadvantage in that the average farm is over 3 miles from the valley station. How important a factor distance is is illustrated by the statement that a farmer within 3 miles of a market can make a labor income four times as large as that of the farmer 7 miles or more away. Despite these difficulties, a large proportion of the farm incomes are derived from cattle production; 40% of the total farm receipts, of which 33% is from milk and butter and 7% from stock sold. This is due to the fact that a combination of milk and crops for sale pays better than the exclusive production of either the one or other, because labor can be kept more continuously employed. From the geographer's point of view it would seem that sheep could be profitably produced on the steep slopes. But the land values are apparently too high for successful sheep raising, and sheep-killing dogs are feared.

In the valley bottoms and on the slopes of the north-south valleys below the thousand foot level as well as over the plain to the north of the Portage escarpment a wide diversity of soils exists. These have essentially the same bed rock origin as the upland soils but consist of

mingled morainic accumulations, glacial outwash gravels, and sands, and clay, and delta deposits of sand and gravel, made on the bottoms of the proglacial lakes. In contrast with the hill soils these soils are usually deep, for the wash of material from over and under the melting glacial front tended to concentrate the deposit of its morainic load around the margins of the projecting valley lobes. Because of this greater thickness the valley soils are free from the poor drainage conditions and drying exhibited by the thin upland soils. The valley soils generally are also richer in lime, a factor of high importance. The partial or complete water assortment of the material has resulted in better textural conditions and their diversity permits of a wider variety of crops on the lower-level soils. Thus apple orchards and vegetable gardens succeed on the well drained, lighter soils. On the whole, however, the crops are much the same as on the uplands, but with better yields and greater profit to the farmer. Only one crop deserves special notice.

Grapes are produced to a limited extent on the east-facing slopes just above the level of Cayuga Lake. The soil conditions are essentially the same on the other side of the lake, but there few or no vineyards are found. This seems to be a response to more genial climatic conditions on the west side, and is especially interesting in connection with statistics indicating an excess of morning sun in April referred to indirectly in an earlier paragraph. The dry alluvial fans that were cultivated by the first settlers on "The Flats" and planted to corn and potatoes are now almost wholly occupied by the city of Ithaca.

INDUSTRY

Water Power as a Factor in the Localization of Industries.—The early industries of the region were nearly all dependent on the water-powers furnished by Fall, Cascadilla, and Six Mile Creeks in plunging through the postglacial gorges to the lake level from their hanging valley lips. In the aggregate the volume of these powers is considerable. Fall and Cascadilla Creeks descend some 400 feet within a distance of one-half mile. Because of the early development of these powers and the parceling out of the rights to numerous persons it has, however, to date been impossible to utilize the full head provided by the abrupt descent of these streams. With a single hydro-electric power plant and distributing station located at the foot of the gorge of Fall Creek and supplied by the full volume of the stream a much greater amount of power could be secured than is now or has been. The same thing may be said of Cascadilla. But even in this event at least two separate power plants would be required. In other words it is a geographic disadvantage that the drainage of the comparatively

small area that centers at Ithaca should be divided between three streams. The disadvantage does not stop at the power plants. To utilize the fall effectively a large reservoir is needed in the upper valley of each stream, particularly now that the forest has been removed and stream volume fluctuates from floods in spring and fall to mere threads of water in summer. The sites for such reservoirs are, however, available and steps are being taken to develop the Fall Creek power in an adequate way by consolidation and provision for storage.

Even with such development it is doubtful whether the available power from these streams would be sufficient to supply a considerable industrial center as was anticipated in 1835, when, during the period of speculation that preceded the contemplated construction of a ship canal from the foot of Cayuga Lake to Lake Ontario, the sum of $220,000.00 was paid for only a portion ("sundry water-powers") of the Fall Creek power rights. On the scale that manufacuring enterprises were then conducted this price might possibly have proved a profitable investment if raw materials for conversion into finished products had flowed into Ithaca from the outside as was anticipated.

The dependence of the early mills and factories on the water-powers is indicated very clearly by the way they were all scattered along the stream courses. Their nature indicates that they were also dependent on local supplies of raw material to a very large extent. Grist mills came first, then plaster mills; chair, sash and door factories using the local lumber supply, also saw mills; boat yards, building canal boats; a distillery (local corn), tanneries, probably dependent at first on the near by supply of hides but later utilizing only the regional resources of bark, oak and hemlock; oil mills (local flax seed?) and a paper-mill probably dependent on local supplies of rags. At early dates, however, there were numerous textile enterprises, woolen carding and fulling mills, cotton factories and silk mills, which must have received their supplies of raw material from other regions and depended for success on the utilization of the local water powers or cheap labor. A foundry and furnace for iron smelting was established in 1822, by 1834 there were three such enterprises in Ithaca.

It is significant that but few of these industries have survived. Those which were justified geographically in that they were founded on the supply of local raw materials and local demand were prosperous in their day. The others in almost every instance had short careers.

Factors in the Localization of Present Day Industries.—The output of the local factories today consists of very specialized products of high value as compared to their bulk, are furthermore largely the creations of local inventive talent and mechanical skill. This is quite fitting in view of the modern topographic remoteness of Ithaca from

centers of population, routes of commerce, and supplies of bulk raw materials. A factory making a patented chain drive, a shotgun works, a paper mill specializing in waxed papers, an advertising sign plant, an adding machine and an aeroplane company are now the important industries of the place. The last mentioned concern was attracted to Ithaca on their own statement by the geographic advantages of the site in that the level, unoccupied lands of the delta flat and the open expanse of the lake, gave opportunities for starting and alighting safely and in trying out hydroplanes. A motion-picture company established studios on the lake shore, but the enterprise failed, partly because the attempt to utilize the manifold scenic attractions of the Ithaca region was not realized because the high per cent of cloudy weather interfered too much with work "on location."

Two industries making bulk products still exist and are prosperous. These avail themselves of abundant supplies of local raw material, of the facilities for cheap water transportation (much enhanced by the barge canal) and of the exceptionally favorable conditions of location for the manufacture of their respective materials that the region affords. They are the salt plants and the cement plant situated on the east side of the lake near Ithaca.

To recover the salt double tube wells are sunk 1,800 feet or more to the salt beds which themselves are 300 or more feet thick. Water sent down one tube issues from the other as a saturated salt solution, and is conveyed to settling tanks on the steep hill-slope. After precipitation of gypsum and other impurities the concentrated brine is evaporated with artificial heat, the salt dried centrifugally, and accumulated on the floor of a store house at lake level, whence it is readily shipped either by water or on the railway that parallels the shore line. There is also a salt mine, 2000 feet deep, producing large quantities of very pure rock salt.

The cement plant is a conspicuous example of the positive influence of a combination of favoring geographic factors in conducing to the prosperity of a particular enterprise otherwise handicapped. The margin of profit in the cement industry is relatively small, the capitalization required per ton of actual product is the same as that in the pig iron industry, but the finished iron product has a value from three to four times greater than that of the same amount of cement.[16] The tremendous modern use of cement has made possible large scale production in plants of maximum industrial efficiency. The Cayuga plant is comparatively distant from the large centers of consumption but has other advantages that outweigh this handicap.

[16] Eckel, E. C., A Comparison of the Iron and Cement Industries, *Cement Age* March 1911 pp. 139-143; also The Cement and Iron Industries, a Comparative Study *Eng. Mag.* March, 1911, pp. 854-867.

Its supply of raw material is furnished by the Tully limestone and the Hamilton shale which underlies the limestone. At the exact site of the plant the rocks have been folded into a low arch which has resisted erosion because of the durable limestone formation that caps it. The glacial erosion of the north-south Cayuga Lake trough has created a steep slope from the lake shore to the crest of the arch which is just behind the mill at an altitude of 259 feet above the lake level. Glacial erosion has removed practically all the weathered rock material. The absence, in appreciable quantities, of residual clay in the joint and bedding planes renders unnecessary the washing operation to remove such substance that must be adopted in some cement quarries in the United States that are located outside the zone of notable glacial erosion. The limestone is 18 feet thick at the quarry, thus of ample bulk for large scale production. As much larger quantities of limestone are needed than of the Hamilton shale at its base (into which it passes abruptly) it is of considerable significance that the shale is below, for if it were above the cost of its removal or timbering would make the enterprise much less profitable. The chemical composition of both formations is exactly that necessary for the production of cement. No imported ingredient is required. The steep slope and the amount of elevation above lake level make possible the use of an aerial tramway to carry the rock directly from the quarry face to the upper story of the mill, for grinding, without expenditure of power.

This series of geographic advantages has made possible the profitable operation of a small cement mill in competition with much larger plants less favorably situated. The geographic disadvantage of being comparatively remote from centers of consumption, Buffalo on the west and New York on the east, is offset in large part by the availability of a water transportation route to those points. Without these geographic advantages the plant could not have survived, possessing them it attracted the attention of a large corporation which developed it from a local enterprise to an industry of state wide importance.

The Environment of the University.—The dominating factor in the development of modern Ithaca as a residential center has been the selection of the place as the site of Cornell University. The founder, Ezra Cornell, was indifferent to having his name attached to the institution but was insistent on the site at Ithaca in preference to Syracuse, where it was urged that the university should be located. In this he was amply justified if beauty and natural interest of situation count for anything in the placing of an institution of learning.

The campus occupies the interstream plateau between Fall Creek and Cascadilla Creek. This is of ample dimensions to accommodate the university buildings and grounds to provide also on the east the

farm acreage necessary for the Agricultural College experimental plantings. It is a rather adventitious geographic advantage that this limited area of farm land should have very diversified soils, till, moraine, glacial lake sands, silt, and clay, and delta material, giving opportunity for tests under a variety of soil conditions. The flat tops of the delta terraces that flank each of the boundary creeks have also provided admirable sites for a number of the buildings.

The west edge of the quadrangle is just above the over-steepened slope of the glacially-eroded Cayuga Lake Valley, hence commands a view of the country for miles around. To the north one looks over a long expanse of lake; to the west down on the city in the valley below, and across it on a wide extent of field and woodland-chequered hillside. On the southeast the prospect is even more distant and extends far into the bold and rugged topography of the uplands. It is commonly felt that no inconsiderable fraction of the institution's cultural and educational influence is owing to its aesthetic surroundings, and the site is considered by many to be the most attractive of all the seats of higher learning in America. To this scenic attractiveness must also be added the unique opportunities for natural history studies, including geography, that the complicated physiographic development of the region affords, and which entails the existence of extremely varied habitats for both flora and fauna, making it in consequence an exceptionally rich and compact collecting ground for the botanist and zoologist; as was early remarked by the celebrated naturalist, Louis Agassiz.[16]

The University as a Factor in the Growth of Ithaca.—Itself admirably situated, the university, as stated before, is responsible also for the modern growth of Ithaca as a residential center. This dates from about the time when the city's dream of future commercial greatness had been finally dissipated. Since then the interests of the population have been divided between the business district on the valley flat and the campus at the crest of the oversteepened slope, separated primarily by a difference in altitude of some 400 feet. The result has been the development of a hillside town instead of a town where there was ample room for residential growth on comparatively level lands to the south and west. Practically all the hillslope between Fall and Six Mile Creeks is covered with residences.

Topographic Difficulties in Intra-City Communication.—The actual distance from the campus to the business center of the city is short, but the direct down hill streets are so steep as to be exceedingly tiresome to climb and dangerous to descend in winter when there is an

[16] Further details on this topic may be found in "The Flora of the Cayuga Lake Basin, New York" by K. M. Wiegand and Arthur J. Eames, Memoir 92, Cornell University, Agricultural Experiment Station, Ithaca, May, 1926.

ice and snow cover. This steepness has also made the transportation problem difficult. The grades are too heavy for trolley lines to negotiate directly. Hence circuitous routes are necessary, with diagonal ascents of the slopes. Even under those conditions the motors must be geared very low, high rates of speed are impossible. The combination of roundabout routes and low speeds make anything like rapid transit from the valley to the campus out of the question. Moreover, even with their long routes the trolleys do not serve a wide area. The upshot of this, in connection with the utilization of practically all the plateau area by the university is that the extent of available residential tracts is quite limited. Conservation of time and energy necessitates living at some place convenient to both the town and the campus for a large part of the community. These circumstances conjointly have developed the condition of high prices for lands, and exceedingly high rents for apartments in what is in other respects a village residential center. The hillside site has also made the matter of fire protection a difficult problem which is further aggravated by the fact that most of the apparatus is housed in the valley because the university is exempt from taxation. Modern motor fire trucks have, however, done much to overcome this difficulty.

The Geography of the Water Supply.—The water supply, too, was for a long time inadequate, but by availing itself recently on a proper scale of the really excellent opportunity afforded by the geographic conditions for creating a sufficient reservoir the community has solved the water problem. It will be recalled that the characteristic features of the bottoms of the hanging valleys, just above their lips, are a succession of amphitheatres and connecting rock gorges, developed as the streams flow in and out of their earlier interglacial courses. One of these gorges in Six Mile Creek has been closed by a high dam and the amphitheatre in the interglacial gorge above it flooded, providing an ample reservoir at low cost. At an earlier date much of the water supply was secured from artesian wells and such water is now used to some extent for making artificial ice. Owing to an unwillingness to recognize the local origin of these artesian waters they were overdeveloped in an attempt to supply the whole community with them.

GEOGRAPHICAL INDEX OF THE FUTURE

It is comparatively simple to recount and point out the geographic influences that have and are contemporaneously exerting an effect on the personal and collective fortunes of a community. To predict what conditions will be important in the future or to suggest better utilization of resources at hand is more difficult and open to criticism as opinions may differ. But such effort constitutes a phase of applied geography and hence is deserving of some exposition.

The transportation prospect of the future for the region is the maximum utilization of the Ithaca terminal of the barge canal. The salt and cement companies will avail themselves of this to a very large extent in shipping goods both east and west. Water transportation is so much cheaper than railroad transportation that if the cargoes were available there could be no question of barge canal shipment being profitable. Bulk cargoes other than salt and cement would need to be furnished largely by agricultural and lumber products. It might be feasible also to maintain a passenger steamer plying the length of the lake if automobile tourists and their cars could be carried efficiently for a half day trip each way. Such a steamer would need to be fast and commodious to be successful.

The development of the agricultural bulk products would necessitate providing roads to the upland sections with hard surface and low enough grades for successful motor truck transport. This is being done rapidly through a system of county highways which supplement the State automobile roads. It would also need co-operation among the farmers to provide an adequate quantity of export products. But potatoes, apples (properly graded and packed) and beef cattle in view of rising meat prices could be shipped, and are all adapted to production in quantity in the region. With proper reforestation of the hillslopes and summits there would also be a constantly increasing supply of valuable pine lumber to send out. For return cargoes western corn for cattle fattening and perhaps bituminous coal and coke from Lake Erie ports could be secured.

Industrial expansion ought to be largely along the line of specialized manufactures, requiring intelligent labor, such as are now successfully established at Ithaca. The presence of the University would provide an incentive for the removal of skilled artisans. Other salt and cement companies might find it profitable to establish plants. An increasing volume of high value small bulk products, package freight, would compensate the railroads, at least in part, for any loss in traffic on account of barge canal shipments. The consolidation of the waterpowers of Fall Creek by a reservoir and central converting plant would be of great industrial advantage.

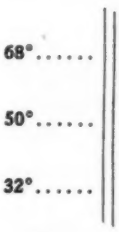
THE TEMPERATURE REGION MAP†*

A. E. PARKINS

INTRODUCTION

The Temperature Region map shows the distribution of selected types of temperature conditions. It is the temperatures of the hottest and coldest months that determine the type as the names of the various regions listed in the legend indicate.

Nine temperature regions are recognized (see legend) on the map. These are derived from but four types of months: hot, mild, cool, and cold.



Key to Types of Months

Fig. 2

The temperature equivalents and limits of each of these type months are shown in the "Key to Types of Months," which may be thought of as a thermometer "scale" calibrated to monthly averages or means, with the three points, 68 degrees, 50 degrees, and 32 degrees, marked thereon. (These three temperatures on the Fahrenheit scale are equivalent, of course, to 20 degrees, 10 degrees, and 0 degrees on the Centigrade.)

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* Koppen was probably the first to conceive the idea of showing the distribution of the temperature conditions of the world by means of temperature region maps. Professor Jefferson has used a modified and simplified form of Koppen's map in his Teacher's Geography. Herbertson presented the idea of temperature regions—illustrated by a world map, to the Royal Geographic Society in 1912. This map has since been issued in the Oxford Series as "Thermal Regions of the World." Andrews in his "Text Book of Geography," in the general discussion of each continent devotes several pages to temperatures and temperature regions, adopting in toto the thermal regions of Herbertson; but he does not show a thermal region map. This paper is written as an appeal to geography teachers and writers of geographical literature for a greater and wider recognition and use of the "Temperature Region" idea. The author has nothing new to offer, except a map more carefully drawn, i.e., more detailed, than Herbertson's and an interpretation of this map not found, as far as he knows, in any text.

On the map that the writer is presenting herewith the general principles used by Koppen, Jefferson, and Herbertson in delimiting the regions are adopted and the nomenclature is a hybrid of that used by Jefferson and Herbertson. Data for more than 2000 places were used in drawing the boundaries. These data were plotted on physical maps of a scale sufficiently large to bring out many details in surface features.

The works consulted for temperature data were Hahn, Klimatologie, III; Bulletins Q and W, and a few other publications of the U. S. Weather Bureau; Publications of the Canadian Weather Bureau; Knox, Climate of Africa; Taylor, Australian Meteorology; Kendrew, The Climates of the Continents; Andrew, A Text Book on Geography; Blanford, Climates and Weather of India, Ceylon, and Burmah; and various standards texts on geography, as well as geographical and meteorological periodicals.

† All copyright privileges reserved by the author.

The boundaries of the temperature regions are surface isotherms. Six isotherms are used, namely, the 68 degree, the 50 degree, and the 32 degree for the warmest months, and the 68 degree, the 50 degree, and the 32 degree for the coldest months respectively. (July and January are taken for the warmest and coldest months in the Northern Hemisphere and for the coldest and warmest in the Southern.)

The Temperature Region map is, therefore, also a surface isothermal map on which are superimposed the three isotherms, the 68 degree, the 50 degree, and the 32 degree for July and the same three for January.

TEMPERATURE CONDITIONS IN THE VARIOUS TEMPERATURE REGIONS

In the **Always Cold** regions no month has an average temperature above 32 degrees. A place with an average of 32 degrees for the hottest month would lie on the boundary of the region.

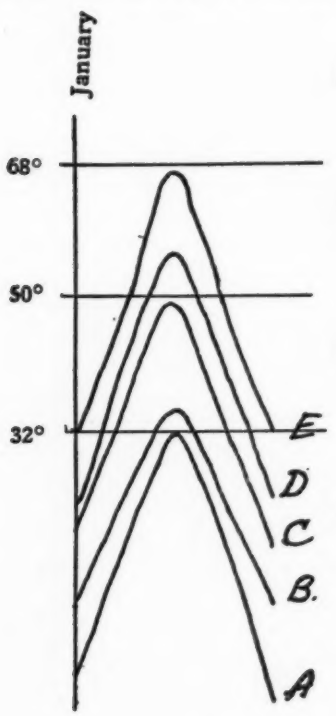


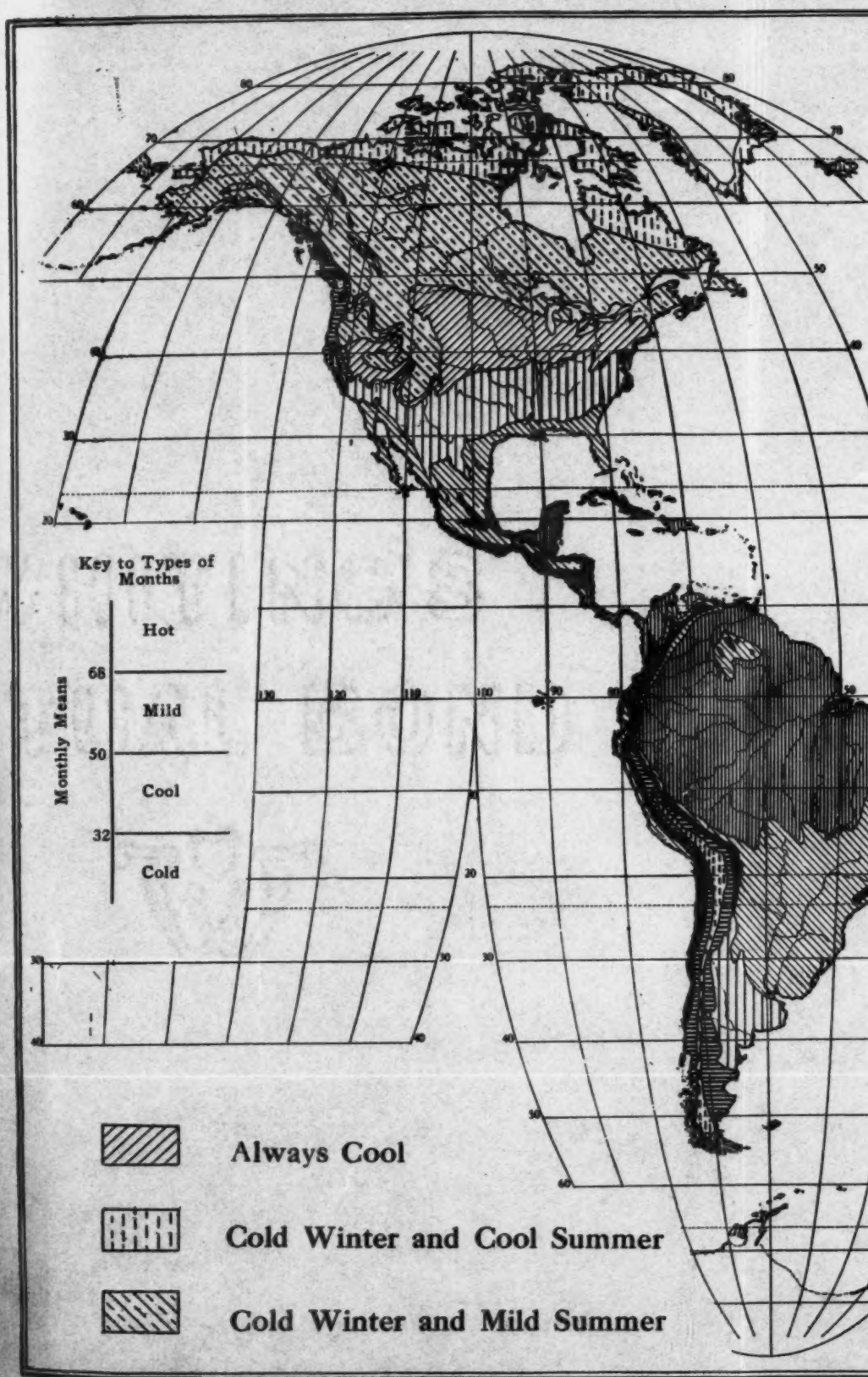
Fig. 3

A typical temperature curve for a place in an **Always Cold** region in the Northern Hemisphere, the year beginning with January is A, Fig. 3. This place would lie near the borders of the temperature region since the warmest temperatures are only slightly below 32 degrees. (The range of the curve shown is 36°.)

The temperature of the coldest month in a **Cold Winter** and **Cool Summer** region is below (colder than) 32 degrees and for the warmest month, between 32 degrees and 50 degrees.

Curved form B is typical for places on the poleward border of this region, while curve form C is for places near the equatorward side (Northern Hemisphere).

Places near the equatorward border would have several months whose temperature averages would be above 32 degrees, and similarly those near the poleward border, several months


Key to Types of Months
Monthly Means
Hot
68
Mild
50
Cool
32
Cold
Always Cool
Cold Winter and Cool Summer
Cold Winter and Mild Summer

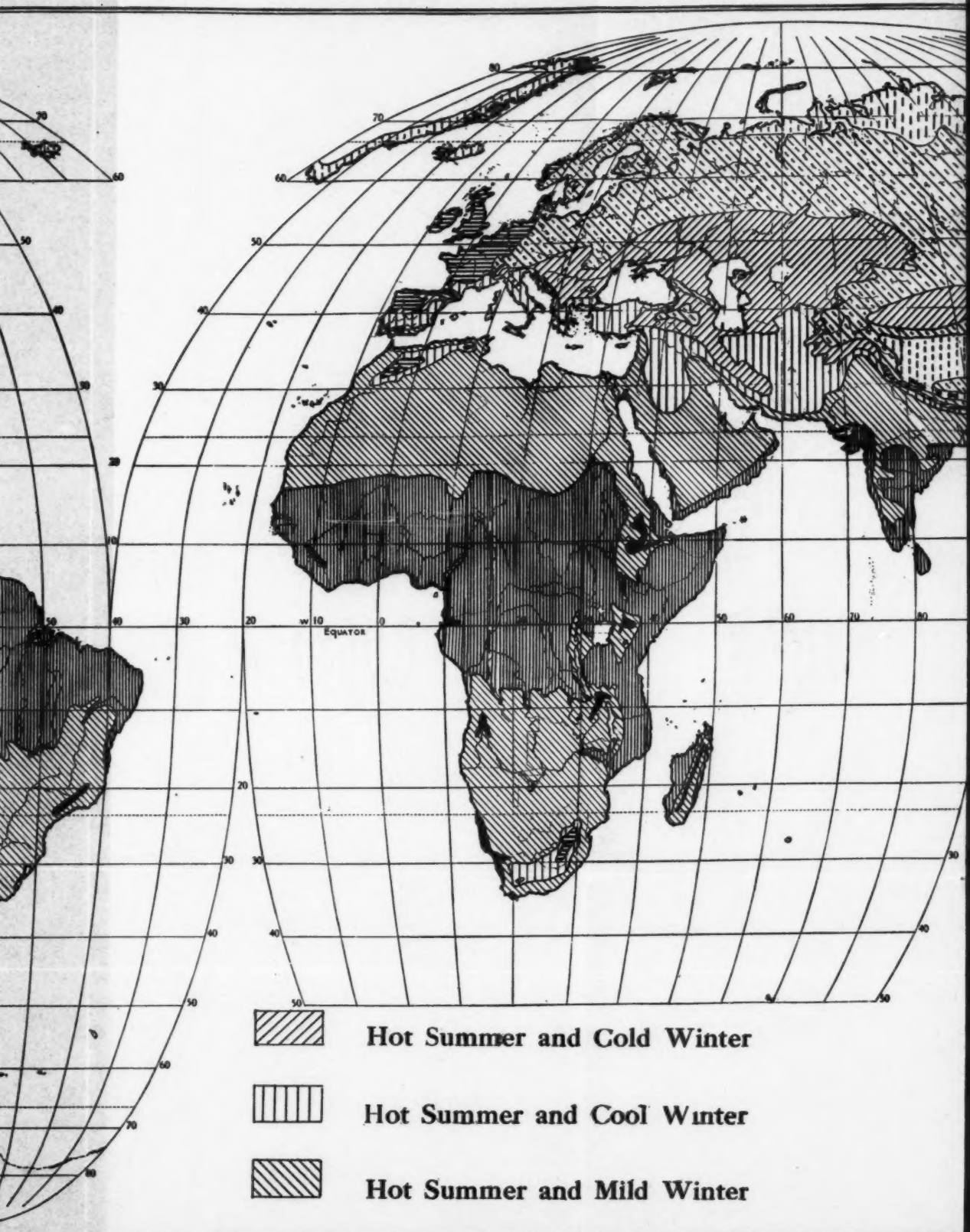
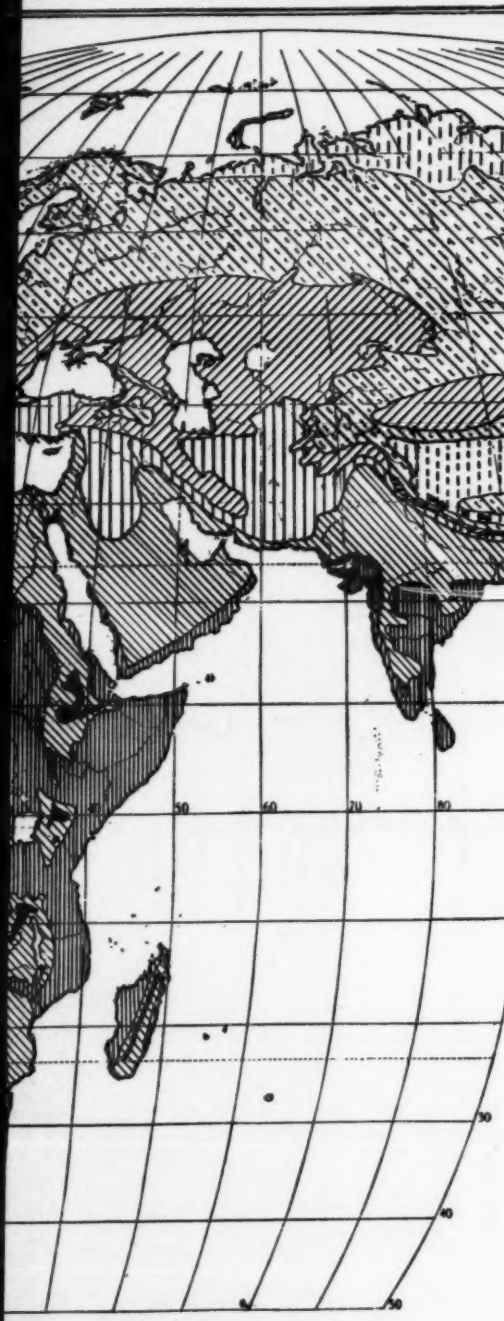


Fig. 1: Temperature Regions on Goode's Homolographic Projection.
Base Map Copyrighted by the University of Chicago Press.

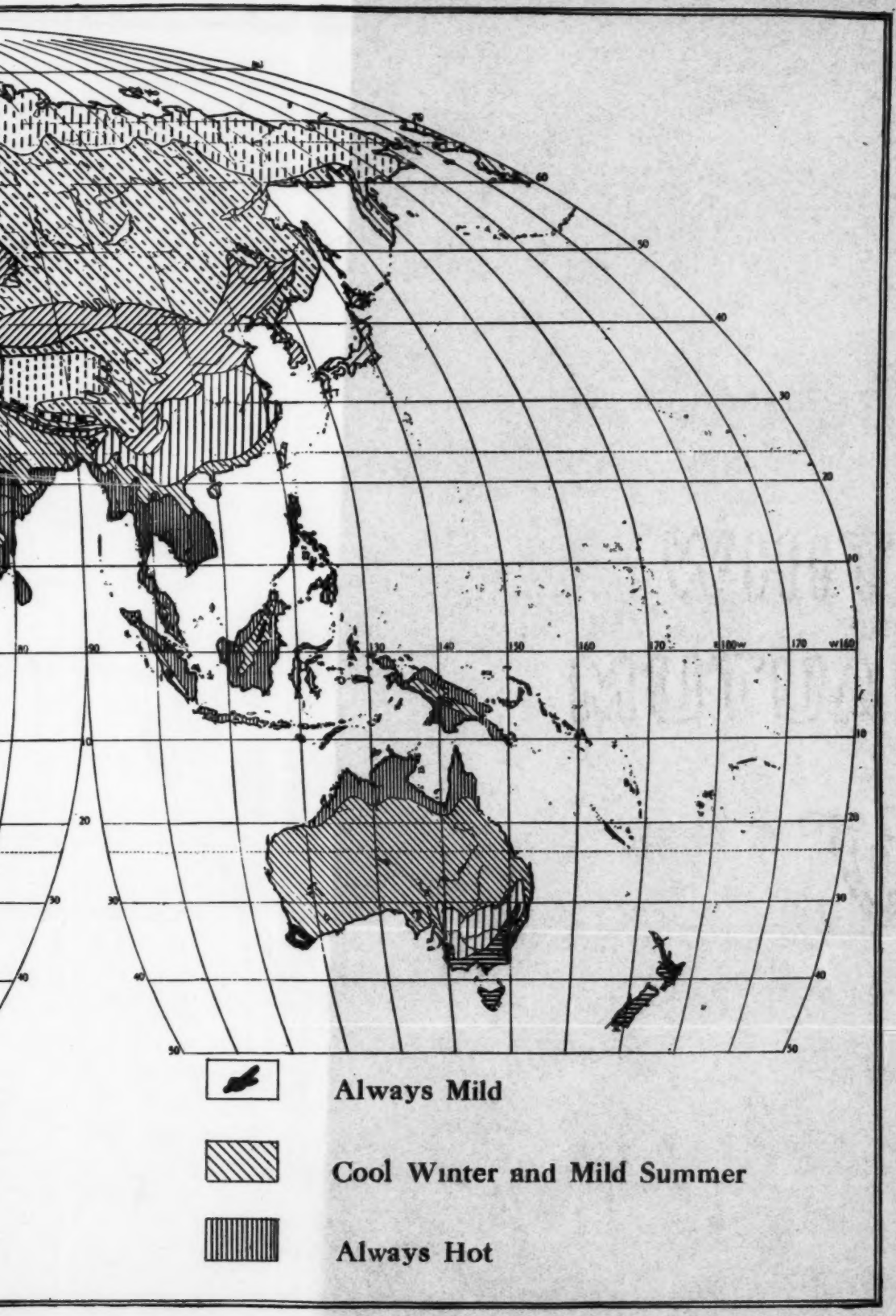


Cold Winter

Cool Winter

Mild Winter

Homolographic Projection.
of Chicago Press.


Always Mild
Cool Winter and Mild Summer
Always Hot

below 32 degrees. The poleward boundary of this belt is the 32 degree isotherm for July and the equatorward boundary is the 50 degree isotherm for July.

In the **Cold Winter** and **Mild Summer** region the average temperatures of the hottest months at any place would lie between 50 degrees and 68 degrees, and for the coldest below 32 degrees. Curve form D is typical for places near the poleward side of this region and form E for the equatorward side. (The range is about 32° for each.)

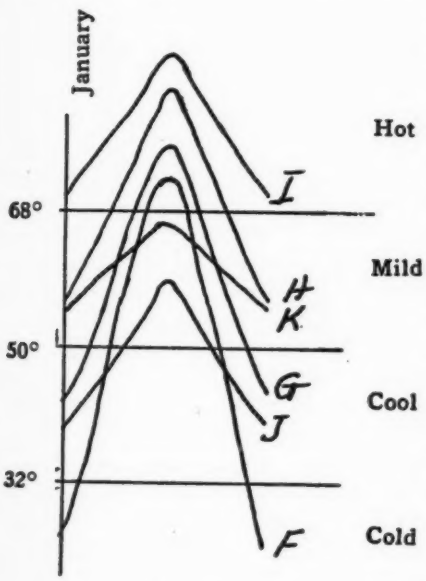


Fig. 4

F, G, H, and I, respectively, in Fig. 4, show possible temperature curve forms for places in the Northern Hemisphere in the **Hot Summer** and **Cold Winter** region, (F), the **Hot Summer** and **Cool Winter** region, (G), the **Hot Summer** and **Mild Winter** region, (H), and the **Always Hot** region, (I). The temperature limits of the hottest and coldest months may be worked out readily by noting the limits of the curves in relation to the three horizontal coordinates. The boundaries of these belts are indicated on the map.

For places in a **Cool Winter** and **Mild Summer** region (see curve form J, Fig. 4) the average of the hottest month at any place is between 50 degrees and 68 degrees and that of the coldest month, between 32 degrees and 50 degrees. For places within the **Always Mild** region (curve form K, Fig. 4) the monthly averages lie between 50 degrees and 68 degrees.

DISTRIBUTION OF THE TEMPERATURE REGIONS

THE ALWAYS COLD REGIONS.—The **Always Cold** regions are found over only a small portion of the land area of the globe. The largest areas are in Greenland and the Antarctic. Extra polar areas having **Always Cold** temperatures, each in general of very small extent, are found at high altitudes in many parts of the world. Mt. Misti, Peru,

at about 19,000 feet has 21 degrees as an average for the warmest month. At 50 degrees north latitude the 32 degree isothermal plane for the warmest month occurs at about 12,000 to 12,500 feet. North of 50 degrees the plane is at lower altitudes, toward the equator at higher altitudes. In equatorial regions it varies from 15,000 feet to 18,000 feet or more. **Always Cold** regions in high altitudes are for the most part co-extensive with the perpetual snow fields.

Cold Winter and Cool Summer Regions.—Regions having the **Cold Winter** and **Cool Summer** type occur on the borders of the Arctic and Antarctic and at moderate to high altitudes in the lower latitudes, as in Tibet and in the higher parts of the Alps. In high latitudes the annual temperature range at many places is 60 degrees or more, but within the tropics it is slight.

The Cold Winter and Mild Summer Type of Region.—**Cold Winter** and **Mild Summer** regions are for the most part continental in their location. They reach the western margin of North America and Europe only in high latitudes. They do not occur in the Southern Hemisphere, because the range of temperature is not great enough. The minimum range of the monthly means that any place may have in this region is 18+ degrees (50+ degrees less 32— degrees). The maximum, as records show, is many times this. Sitka, for example, has a range of 24 degrees, while at Verhoyansk, east of Lena River, the hottest and coldest months differ by 119 degrees.

In the **Cold Winter** and **Mild Summer** regions occur the greatest extremes and the lowest temperature on the globe, both of which are due chiefly to the large land masses and high latitudes. They are the widest of the temperature belts, extreme width being considered. The northern (poleward) borders, which lie for the most part on lowlands, deviate little from the straight east-west line, but the southern borders are irregular, with many outliers still farther equatorward on isolated mountain areas, as in the Pyrenees, the Caucasus and elsewhere. One remarkable fact about the temperature conditions of these regions is the similarity of the July means over large areas, the long period of sunlight in the northern portion in comparison with the southern part no doubt making up for the lower sun. The July mean for Hammerfest is 53 degrees, Archangel 60 degrees, Tobolsk 66 degrees, Moscow 66 degrees, Lhassa 65 degrees, and Vladivostok 66 degrees. The January means, however, differ greatly even along the same parallel. Christiania (Oslo) has 24 degrees for the January mean, Petrograd, 15 degrees, Yeneseisk, 10 degrees, and Okhotsk, 10 degrees. Lhassa on the southern border has a January mean of 27 degrees and Verhoyansk, —59 degrees.

In North America the boundaries of the **Cold Winter** and **Mild**

Summer region coincide nearly with those of the northern coniferous forest; but in Europe the coniferous forest and most of the deciduous forest areas occur in this temperature belt. In Asia the relation of types of forests to temperatures is somewhat similar to that in North America. In North America only the southern half of this temperature region, in so far as temperatures control, is suitable for cereal production, such as hard spring wheat, oats, rye, and barley. The long cold months in general prove unfavorable for livestock except in regions under the influence of the chinook winds. Even when Canada's eight million population becomes eighty million, the prediction of Lord Strathcona, it will be mainly this southern half, and the small area of **Hot Summers** and **Cold Winters** in the St. Lawrence basin that will be occupied. The northern half of the **Cold Winter** and **Mild Summer** region will remain mainly a land for the hunter the trapper, the herder of the reindeer, the miner, and in parts, the lumberman.

In Europe it is mainly in the southern half of this temperature region that the denser population groups are found. Here occur some of the most densely settled areas of Europe, geographic factors other than temperature dominating.

Cool Winter and Mild Summer Regions.—On the lowlands of the western margin of the continents in the Northern Hemisphere, where oceanic influences dominate, in much the same latitudes covered by the **Cold Winter** and **Mild Summer** type, are the **Cool Winter** and **Mild Summer** regions. The latter are oceanic forms or variants of the continental type. The moderating influence of the ocean is most noticeable on the winter temperatures. Port Simpson (54 degrees N.) on the Pacific Coast has January and July means of 33 degrees and 57 degrees respectively, while Winnipeg (54 degrees N.) has 7 degrees for the January mean and 66 degrees for July. Victoria (48 degrees N.) has 38 degrees and 66 degrees, respectively, for the means of the coldest and hottest months; while Quebec in about the same latitude has 10 degrees and 66 degrees. The **cold** month of continental North America between 50 degrees and 70 degrees N. latitudes (approximately) becomes moderated on the western border of the continent to a **cool** month by oceanic influences; the hottest month in either region being about the same, with temperatures between 50 degrees and 68 degrees F. In Europe the same conditions prevail with regard to January and July temperatures in these two temperature regions. Dublin in the **Cool Winter** and **Mild Summer** region has 42 degrees and 60 degrees as means for the coldest and warmest months, and Moscow, in about the same latitude as Dublin, has 12 degrees and 60 degrees, respectively. The reason for the larger area of the **Cool Winter**

and **Mild Summer** region in Europe in comparison with North America is obvious.

The maximum range of the monthly means that a place may have in this belt is 36— degrees (68— degrees less 32+ degrees) and the minimum even less than 1 degree. This type, therefore, may also occur in the higher portions of the tropics and even in continental localities outside the tropics that have a low range of monthly means. Most of Patagonia and southern Chile, south of 40 degrees, is in this region, so also are both slopes of the Andes from 40 degrees S. to southern Peru. Santa Cruz, Punta Arenas, and Valdivia have this type of temperature. So also does Uspallata at 9,300 feet, east of Santiago. Within the tropics in South America this region lies between approximately 9,000 and 14,000 feet. La Paz and Cuzco are in this belt. A part of the Drakenbergs of South Africa, the island of Tasmania, and a part of the Australian mainland just to the north of Tasmania, South Island and a part of North Island of New Zealand, and a narrow strip on the south slope of the Himalayas have the **Cool Winter** and **Mild Summer** type of temperatures.

Everywhere on the lowlands in this region man finds congenial temperature conditions for his activities. The cool winter favors commerce, fishing, and winter grazing, especially. It is of some importance at least, although other geographic factors and possibly much more important ones, are contributory, that in this type of temperature are most of the great manufacturing, commercial, financial, political, colonial, and intellectual centers of Europe.

Hot Summer and Cold Winter Regions.—The **Hot Summer** and **Cold Winter** regions are continental in their location and occur only in the Northern Hemisphere. Nowhere do they touch the ocean on the western margin of the continent. They have their greatest width in the interior of the continents where an annual range of 36+ degrees or more is to be found, (68+ degrees less 32— degrees). The **Hot Summer** and **Cold Winter** regions do not occur on the tropical highlands because of the low annual range there, nor in temperate South America because of the dominance of oceanic influence. Africa, Australia, and New Zealand are not far enough poleward or are too much influenced by the ocean to have this type represented.

In North America this type extends from the eastern edge of the Western Cordillera to the Atlantic. A small area in the valley of the Columbia in Washington, where oceanic influences are intercepted by the Cascades, has hot months above 68 degrees and cold months below 32 degrees. The hottest and coldest months, for example, at Lakeside, near Lake Chelan, are 73 degrees and 26 degrees, and at Spokane 69 degrees and 27 degrees.

In Euro-Asia the position in latitude of the **Hot Summer** and **Cold Winter** region is much the same as in North America. This type occurs on the south slope of the Alps, on the plains of Hungary, and in the Balkans states, in southern Russia, central Asia, Persia, Afghanistan, and northwest India, in Sinkiang, and in China proper.

Hot Summer and Cool Winter Regions.—The **Hot Summer** and **Cool Winter** regions are likewise continental in type (the minimum range is 18+ degrees, i. e., 68+ degrees less 50— degrees) but not as extreme in range as the **Hot Summer** and **Cold Winter** type. They occur in both Northern and Southern Hemispheres but not on tropical highlands. The boundaries of this belt are the 50 degree and the 32 degree isotherms for the coldest months. As the map shows, this region is found in southern United States from the Atlantic almost to the Pacific, being separated from the Pacific by the **Always Mild** and the **Cool Winter** and **Mild Summer** regions. This type is also on the highlands of Mexico, to the east of the Andes, between 32 degrees and 42 degrees S. latitude, in southern China, on the plateau of South Africa, and in Southeastern Australia.

Hot Summer and Mild Winter Regions.—The maximum range of temperature in the **Hot Summer** and **Mild Winter** type of regions is as much as 40 degrees, as a comparison of data shows, while the minimum may be as little as 1 degree or less. This type may, therefore, be in belts of considerable width in latitude and may also occur on tropical highlands as in Andes and the highlands in east tropical Africa. The boundaries of the belts are the 50 degree and 68 degree isotherms for the coldest month.

The Always Hot Region.—The **Always Hot** region, occupying and being in a portion of the globe where the sun is always high above the horizon, nearly 90 degrees, is the widest in average latitudinal extent of all the type regions. Its boundaries are the 68 degree isotherms for the coldest month in either hemisphere. It is a lowland or a plateau type and not a high altitude type for obvious reasons.

Always Mild Regions.—In the areas that have **Always Mild** temperatures, the maximum range must be less than 18 degrees and may be even less than 1 degree, inasmuch as the averages of the month must lie between 50 and 68. It is, therefore, an oceanic subtropical lowland or a tropical highland type. As a subtropical type it occurs on the windward side of the continent, as on the California coast, the coast of Chile, northwest and southwest Africa, southwest Australia, on the coast of South Australia, and in New Zealand. Within the tropics it lies in altitude above the **Hot Summer** and **Mild Winter**

regions (as the map shows), on the slopes of the Andes, on the plateaus of eastern Africa, and the higher lands of the East Indies.

TEMPERATURE REGIONS ON SLOPES OF MOUNTAINS AND ON HIGHLANDS

That the slopes of a lofty mountain in the tropics show all the degrees of temperature from base to summit that occur from equator to pole is a statement with which we are all acquainted. This is true for yearly, monthly, or daily averages, but we cannot find on such slopes all the different temperature regions or types that we do on the plains from equator to pole. Mountains within the tropics have only those types characterized by a low range of temperatures; and mountains outside the tropics, types of regions characterized by a great range. The oceanic side of mountain ranges bordering or near the ocean show oceanic influences in their temperature regions.

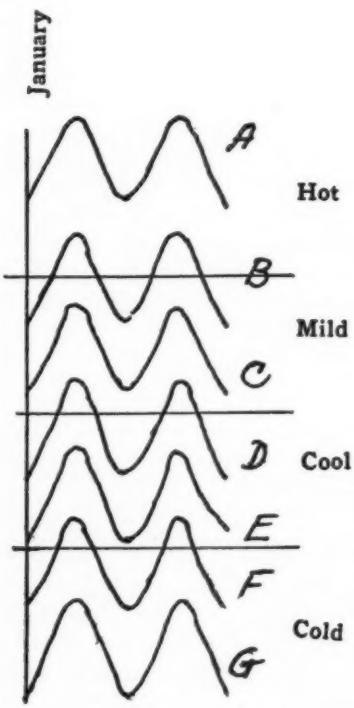


Fig. 5

The Sequence Within the Tropics. — Fig. 5 shows a sequence of curve forms for various places at increasing altitudes on a mountain slope near the equator, the lowest in altitude, having the uppermost curve form on the diagram. With an ascertained range for the lowlands in the tropics, say 12 degrees—a range typical for many parts of the tropics—, the vertical sequence of temperature regions is easy to determine. It is **Always Hot, Hot Summer** and **Mild Winter, Always Mild, Cool Winter** and **Mild Summer, Always Cool, Cold Winter** and **Cool Summer,** and **Always Cold.**

On ascending the eastern slopes of the Andes, in northern Bolivia, for example, one passes out of the **Always Hot** region through the **Hot Summer** and **Mild Winter** region, the **Always Mild** region, the **Cool Winter** and

Mild Summer, the **Cold Winter** and **Cool Summer** (**Always Cool** is not differentiated on the map from the **Cold** and **Cool**), and on into the **Always Cold** (not shown on the map because of small area). Ste. Ana, a small town in the "Montaña" of Peru at about 3,400 feet A. T. has **Always Hot** temperatures. Cochanamba at about 8,400 feet is in the **Always Mild** region with the **Hot Summer** and **Mild Winter** region below. Cuzco at about 11,000 feet is in the **Cool Winter** and **Mild Summer** region, and on Mt. Misti, are the other regions in the order previously named. The temperatures at Mt. Misti (top) are 21 degrees and 13 degrees respectively for the warmest and coldest months. The western slope of the Andes in about the same latitude shows the same sequence of regions.

In Africa there are no large areas of highlands sufficiently lofty to be in regions colder than the **Always Mild** type, i. e., 50 degrees for the coldest month. Most of the highland area of tropical Africa lies in the **Hot Summer** and **Mild Winter** region, but a part of the plateau of Abyssinia and the highest parts of British East Africa, Kenya Protectorate, German East Africa (Tanganyika Territory) have **Always Mild** temperatures. The few lofty peaks no doubt have other types characteristic of tropical mountains, but the writer could find no data to establish this.

SEQUENCE ON MOUNTAINS IN THE TEMPERATE ZONES.—On the western slope of the Sierra Nevada the belts are **Hot Summer** and **Cool Winter**, **Cool Summer** and **Mild Winter** and **Cold Winter**, and **Mild Summer**, a sequence analogous to the horizontal poleward sequence west of the mountains. The temperature types on the western slope of the Sierra Nevada thus shows slight oceanic influence. On the eastern slope Cedarville at 4,670 feet lies in the **Hot Summer** and **Cold Winter** region, thus showing that vertical sequence on the east and west slopes of the Sierra Nevada is not the same (that on the eastern slope showing continental influences). On the slopes of the Alps the vertical sequence is the same as the continental lowlands in the North Temperate Zone, a result of the location of these mountains beyond the influence of either the ocean or the constant high sun of the tropical lands. The south slope of the Himalayas bordering the subtropical Ganges-Brahmaputra plain shows a moderating influence of some sort. Kabul (6,234 feet), Srinagar (5,204 feet), and Darjeeling (7,400 feet), are in the **Cool Winter** and **Mild Summer** region, not the **Hot Summer** and **Cold Winter** type. This latter type occurs both to the west and to the east. See the map. The lower range at Simla and Darjeeling is due no doubt to the

protection from cold northerly winds offered by the lofty plateau of Tibet and the high Himalayas and the high relative humidity, and heavy summer rains.

SEASONAL MIGRATION OF ISOTHERMS AND THE BOUNDARIES OF THE TEMPERATURE REGIONS

The temperature regions, as previously stated, are bounded by the surface isotherms of 68 degrees, 50 degrees, 32 degrees for the hottest and the coldest months. While these particular temperatures are selected arbitrarily they after all have a geographic basis. The significance of 32 degrees is obvious. The 50 degree isotherm for the warmest month marks, approximately, the poleward limit of tree growth and the 68 degree isotherm for the coldest month, approximately, the poleward limit of the palms.

On a plain stretching from high to low latitude in the Northern Hemisphere, not affected by oceanic influences, the sequence (isotherms for both seasons being considered) of surface isotherms from north to south is 32 degrees for the hottest month, 50 degrees for the hottest, and 68 degrees for the hottest, 32 degrees for the coldest, 50 degrees for the coldest, and 68 degrees for the coldest. See the map and Fig. 6.

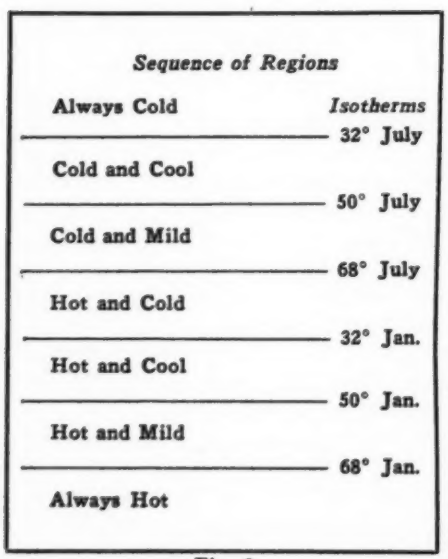


Fig. 6

This sequence may be considered the normal one, in that part of a continent having continental temperatures, a result of the decreasing sun angle with increasing latitude and the north-south migration of the sun. This arrangement of isotherms gives rise to seven types of regions, namely, in order from north to south in the Northern Hemisphere: **Always Cold, Cold Winter and Cool Summer, Cold Winter and Mild Summer, Hot Summer and Cold Winter, Hot Summer and Cool Winter, Hot Summer and Mild Winter, and Always**

Hot. Were all the land of the globe a plain with a continental temperature there would be only these seven types of regions, and these would extend in parallel belts across the lands of the world. In the north-south shifting (seasonal migration) of the 68 degree, 50 degree, and 32 degree isotherm on a lowland with continental temperatures the whole set shifts in due order and there is no crossing of the isotherms. The three for the hottest month (July) lie wholly poleward of the three for the coldest month.

On the windward border of the continent the ocean exerts a retarding influence on the migration and the sequence is wholly unlike that in the portion of the continent dominated by continental temperatures.

In western North America, for example, the 68 degree isotherm in its northward march and the 32 degree and 50 degree in their southward march are retarded and two other types of temperatures result: **Cool Winters** and **Mild Summers** and **Always Mild.** The relative position of the isotherms for the hottest and coldest months on the western margin and the portions of the continent to the east is shown on the isothermal map. Trace the 68 degree isotherm for July across the map; also the 32 degree for January and the 50 degree for January.

In South America there is a similar retardation of the isotherms in their seasonal migration as a study of the map shows. The 68 degree isotherm migrates southward from July to January only through about 15 degrees or 16 degrees of latitude. The 50 degree isotherm is simlarly retarded on the west coast in comparison with the movement on the eastern slope of the continent. The sequence of isotherms from equator to pole on the Atlantic slope in South America is 68 degrees for the coldest and 50 degrees for the coldest; 68 degrees for the hottest and 50 degrees for the hottest; on the western slope it is 68 degrees for coldest and 68 degrees for hottest; 50 degrees for coldest and 50 degrees for hottest months. The poleward sequence of temperature regions is, therefore, not the same on the Pacific slope as on the Atlantic slope of South America. South America does not extend poleward sufficiently for any except the highest part of the highest mountains to have a January average (hottest month) of 32 degrees or below, and the 32 degree isotherm for the coldest month, occurs only on the highest portions of the Andes.

In southwestern Africa the 68 degree isotherm in its southward march with a southward moving sun is retarded in the western coastal

district by the cool wind off the South Atlantic current, and **Always Mild** temperatures occur, even to the border of the tropics. On the eastern side of the continent the Mozambique Current retards the northward march of the 68 degree isotherm and brings the **Always Hot** temperatures to 20 degrees S.

Mountains and plateaus result in many complications in the migration of isotherms. They produce a vertical migration which on a flat map gives the appearance of a horizontal retardation. On highlands that have the continental type of climate the vertical sequence of isotherms is the same as the poleward horizontal sequence.

It is this sequence of isotherms that gives the temperature region sequence suggested above in the discussion of the temperature regions on the slopes of mountains. For example, in northwest India the sequence is 50 degrees for the coldest, 32 degrees for the coldest, 68 degrees for the hottest, and 50 degrees for the hottest, and in higher parts, 32 degrees for the hottest. In the Alps the sequence is the same, starting with 32 degrees for the coldest month. In the Atlas Mountain region the sequence is 50 degrees for coldest, 68 degrees for hottest, and 32 degrees for the coldest. Similar to the sequence on the western slope of the Sierra Nevada is that on the south slope of the Himalayas, starting with 68 degrees for the hottest month on the lower slopes from Simla to Darjeeling, inclusive, with the 50 degree isotherm for hottest and 32 degrees for the hottest farther up the slope. This is the sequence then in "subtropical" latitudes where there is a moderating influence on the temperature range and, therefore, on the amounts of vertical migration. On mountains in regions of low temperature range there is the same retardation of isotherms in their vertical migration as there is in their horizontal migration.

ESTIMATING TEMPERATURES

When one understands the basic principles of the Temperature Region map, estimating the temperatures of the coldest and warmest months at selected places may be done with a remarkable degree of accuracy. It is comparatively easy to estimate the correct, or nearly correct, temperature of one of the months but more difficult, usually, for the other because the isotherm from which reckoning is made is distant from the place selected.

Let us as an illustration of what may be done, try to estimate the temperatures of the hottest and coldest months at Chicago from the map. Chicago lies near the middle of the **Hot and Cold** belt of temperatures. Refer to the map. It is south of the 68 degree isotherm for July and north of the 32 degree isotherm for January. The July temperature is therefore warmer than 68 degrees, and the January colder than 32 degrees. The temperature gradient between Chicago and the 32 degree isotherm for January is undoubtedly very similar to that between the 50 degree for January and the 32 degree for January, since there is a general uniformity in altitude. The average January temperature for Chicago, therefore, is about 25 degrees. If the July temperature gradient south of the 68 degree isotherm is similar to that between the 50 degree and the 68 degree isotherm for July, Chicago will have a July temperature of about 71 or 72 degrees. Weather bureau data give 72 degrees as the July temperature and 24 degrees as the January.

Another illustration: New Orleans lies a short distance south of the northern border of the **Hot Summer** and **Mild Winter** region. Its January temperature will, therefore, be a little hotter than 50 degrees and its July much hotter than 68 degrees, since it lies far to the south of the 68 degree isotherm for July. The estimating of the latter temperature will be different for reckoning must be made from this 68 degree July isotherm in the northern part of the United States. If the gradient from Chicago to New Orleans is similar to that between the 68 degree July isotherm and Chicago, New Orleans should have a July temperature of 85 degrees or 86 degrees, but the summer temperature is slightly tempered by gulf. Weather Bureau data give 81 degrees for July and 53 degrees for January.

When once a tentative gradient has been established by comparison of the temperatures of a few well chosen places, the task of estimating temperature is comparatively easy.

Problems in estimating temperatures will prove both interesting and profitable to the students.

DRAWING TEMPERATURE CURVES

With proficiency, gained by practice, in estimating temperatures one is equipped to draw temperature curves for any part of the earth, *provided* he knows the "forms" of the temperature curve characteristics of the different latitudes.

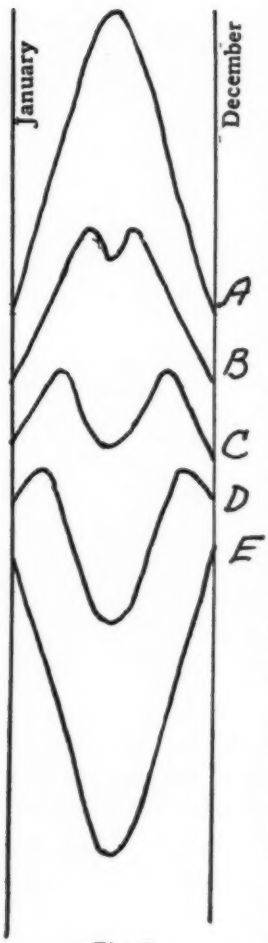


Fig. 7

A, B, C, D, and E in Fig. 7 are the temperature curve forms, each curve beginning with January, for each of several latitudes. Curve form A is for places poleward (northward) from 23½ degrees N. The range of temperature will vary but the general form remains much the same. B is for places from 12 degrees to 20 degrees north of the equator. C is for places on or near the equator, if sun influence alone dominates. D is for places from 12 degrees to 20 degrees south of the equator, and E is for places south of 23½ degrees S.

For practice let us attempt to draw the curve for Louisville, Kentucky. This city is in the northern portion of the **Hot Summer** and **Cool Winter** belt of temperatures and lies north of 23½ degrees. Its hottest month, estimating as discussed in the preceding section, is approximately 9 or 10 degrees warmer than 68 degrees and its coldest month slightly warmer than 32 degrees. Weather Bureau data give 79 degrees and 34 degrees for the hottest and coldest months.

The form of the curve is similar to A of Fig. 7. The highest part of the curve will be slightly above the 68 degree horizontal coordinate and the lower parts of the curve just above the 32 degree coordinate. (Refer to F, Fig. 3.)

Para, which lies in the **Always Hot** belt and near the equator, would have a curve form like C and all portions of the curve would lie above 68 degrees horizontal co-ordinate.

Salisbury in southern Rhodesia at approximately 18 degrees S. and in the **Hot Summer** and **Mild Winter** region, would have a "form" like D, with the two portions of the maximum much above 68 degrees and the minimum between 50 degrees and 68 degrees in temperature.

Buenos Ayres, Argentina, has a form much like E. Its position

within the temperature region would aid one in fixing its place with respect to the horizontal co-ordinates.

SOME ADVANTAGES OF THE TEMPERATURE REGION MAP

The Temperature Region map is a surface temperature region map and also a surface isothermal map within two sets of isotherms superimposed. It, therefore, possesses all the advantages of two surface isothermal maps (hottest and coldest months).

It is superior to isothermal maps because in the teaching process it calls for the visualizing of areas, not lines. It is undoubtedly easier for the mind to retain mental pictures of areas than pictures of lines.

It shows the seasonal migration of isotherms.

It selects the three most significant isotherms of geography: 68 degrees, 50 degrees, and 32 degrees.

It shows altitude and oceanic effects as well as any surface temperature map.

It aids in classifying the temperature conditions of the world, by showing clearly that the types of one continent are repeated in parts, or entirety, on other continents, where latitude, altitude, and location with respect to water bodies are similar. For this reason it is of great value in making comparisons with conditions in United States regarding agriculture, natural vegetation, and general conditions for living.

It is scientific to the extent that it classifies knowledge.

It removes the haziness in the use of such adjectives as mild, cool, cold, and hot by assigning definite (though arbitrarily chosen) temperatures or temperature ranges to each. It gives a greater definiteness, than one gets from a study of isothermal maps, of the limits of the "tropics," temperate regions, and the Arctic, for it shows the subdivision of those regions in detail, yet not in such detail that the memory is burdened.